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Measurements in daily life

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CHRIS PULHAM
EDITOR/WEBMASTER, BIML

World Metrology Day 2013

As we go to press, the World Metrology Day Team has just finished putting the final touches to the 2013 WMD web site. World Metrology Day celebrates the signature by representatives of seventeen nations of the Metre Convention on 20 May 1875 and for several years now, the BIPM and the BIML have joined forces to support and promote the event via a web site and multilingual posters depicting the theme.

The theme we have chosen for this year is *Measurements in daily life*, a field which is as vast and inspiring as last year's topic *We measure for your safety* and just as important as we go about our daily activities.

We are so used to measurements being a part of our everyday lives that we often take them for granted and possibly don't even notice them: for example we (and the authorities!) monitor the speed at which we drive to ensure we travel safely and thus reduce road casualties; we undergo health checks to make sure the components of our blood are within acceptable limits; we use time measurements not only so we are punctual for our appointments but also for satellite positioning systems to pinpoint our location; we consume electricity, gas and water which are billed based on measurements, we buy food based on weight, and so on.

Very often, small errors in either direction average out over a large number of measurements. But biased errors, for example inaccurate measurements of oil across a continent, can have disastrous economic consequences by creating considerable financial prejudice. Similarly, incorrect doses of medicine can have a critical effect on our health or on our safety.

Providing the right tools to ensure the accuracy of measurements is the role of scientific metrology, and making sure that the appropriate technical requirements become part of national legislation is the role of legal metrology. We hope to spread this simple but vital message again this year to the public across the world so that measurements, and the instruments used to make them, are not always taken for granted.

We encourage you to visit the World Metrology day web site at www.worldmetrologyday.org and to participate in the events that will take place in your country. Measure on! ■

BREATH ALCOHOL

Quality assurance of breath alcohol measurements

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Abstract

The Romanian National Institute of Metrology (INM) has started to develop efficient measures to detect drivers under the influence of alcohol. The aim of the project is to ensure accurate results and to assure traceability of the mass concentration of alcohol in exhaled breath.

This paper describes the comparison between measurements performed:

- in the LNE laboratory* using the LNE-CRM, LNE-simulator system and INM-breath alcohol analyzer,
- in the INM laboratory using the LNE-CRM**, INM-simulator system and INM-breath alcohol analyzer, and
- in the INM laboratory using the INM-CRM, INM-simulator system and the INM breath alcohol analyzer.

In addition, the paper describes the complete system used for testing the performance of breath alcohol analyzers and the method applied to prepare and certify the standard solutions. The expanded uncertainty for the complete simulator system was calculated taking into consideration all those input quantities that make a noticeable contribution to the final uncertainty.

Introduction

Romania, as a member state of the European Union, must develop efficient anti drink-driving measures according to the European Road Safety Charter, which is the largest policy document covering all 27 European Union member states.

Over the years, statistics have proved that there is an exponential relationship between the risk of accidents and the mass concentration of alcohol in drivers' blood. At the same time, it was scientifically proven that there is a relationship between the mass concentration of alcohol in human blood and the mass concentration of alcohol in exhaled human breath. In this respect, manufacturers have developed various breath alcohol analyzers that can provide accurate results.

According to the most recent reported statistics, the Romanian Police have greatly reduced the level of alcohol abuse in road traffic accidents. In its attempts to decrease the risk of serious accidents, to detect dangerous driving behavior and to prevent road fatalities, the Romanian Police has been involved in the implementation of various enforcement programs and in this respect, at national level, it works hand in hand with the National Institute of Metrology and with Dräger Romania.

This paper describes the comparison of the results of tests performed within the LNE and INM laboratories and the measurement system developed within the INM both to measure the mass concentration of alcohol in exhaled breath and to assure traceability of the measurement results [4] of [1]. The complete system used to test the breath alcohol analyzers' and/or breath alcohol test devices consists of

- the AlcoCal simulator system based on the depletion compensation principle [9],
- devices used to prepare different sets of standard solutions such as high purity ethanol,
- a mass balance for weighing the mass of ethanol,
- volumetric flasks, and
- a high performance IR&EC breath alcohol analyzer with a traceable calibration certificate.

For each component of the INM measurement system the associated uncertainty budget was calculated, e.g.:

- the uncertainty budget of the mass concentration of alcohol in distilled water;
- the uncertainty budget due to the AlcoCal simulator system; and
- the uncertainty budget of the breath alcohol analyzer,

calculated taking into consideration all the input quantities which make a noticeable contribution to the final uncertainty.

The evaluation of the uncertainty budgets of the mass alcohol solution in distilled water took into consideration the following components:

- uncertainty due to the weighed mass of the alcohol;

* The data performed by the LNE (Laboratoire National d'Essais) was taken into consideration from the testing report issued by LNE on 19.01.2012.

** The tests were performed within the INM laboratory, using the LNE-CRM (Certified Reference Materials), according to the calibration certificates issued by the LNE.

- the uncertainty due to the balance;
- the decanting uncertainty due to pouring the alcohol from the graduated pipette into the volumetric flask during the standard solution preparation;
- the uncertainty due to evaporation;
- the uncertainty due to the ethanol purity and density; and
- the uncertainty due to volume and temperature.

The uncertainty budget due to the AlcoCal simulator system was calculated based on the Dubowski formula, according to which the mass concentration of ethanol present in the vapor phase above the liquid-water mixture depends on just two factors: the temperature of the mixture and the mass alcohol concentration in the liquid [3].

The input quantities which contributed to the evaluation of the uncertainty budget of the breath alcohol analyzer were

- the uncertainty due to the repeatability,
- the uncertainty due to the limited resolution of the device, and
- the uncertainty due to the linearity.

The expanded uncertainty for the complete simulator system was calculated taking into account the evaluation of all the uncertainties presented above.

Overview of traceability in Romania – comparison of the mass concentrations of alcohol

Traceability of breath alcohol concentration is not a new field in Romania. About 2500 breath alcohol analyzers and breath alcohol test devices (manufacturer Dräger) are currently in use; the Ministry of the Interior (Police Department) purchased these instruments several years ago following a European project to equip East European police departments. Since then, the traceability of measurements performed using such instruments has become a priority in order to ensure accurate measurements and their acceptance in court.

Measurements made at different times or in different places are directly related to a common reference. Applying the concept of traceability to breath alcohol measurements is not easy, but traceability has to provide qualitative results using analytical techniques used in calibration laboratories. Specialists from the National Institute of Metrology have started [5] to prepare the basis necessary to transmit the specific unit of measurement, mg/L, from high level standards (reference materials) to the working level measurements.

In Romania certain limits are set for the accepted mass concentration of alcohol in exhaled air - see Table 1. A concentration of up to 0.40 mg of ethanol per litre of expired air is "tolerated" for drivers but carries a penalty of a fine, while a level exceeding 0.40 mg/L is considered a crime. Although only blood measurement results are admissible in court, there is obviously an increased tendency to expand the use of alcohol measurements performed on human breath for legal purposes. In many EU countries breath alcohol concentrations are admissible as evidence in court.

Table 1 Measurement units used to express breath / blood alcohol concentration

Units of measurement for *breath* alcohol concentration		
Microgram alcohol per 100 mL of breath	Microgram alcohol per L of breath	Milligram alcohol per L of breath
µg/100 mL; µg %	µg/L	mg/L
40	400	0.40

	Units of measurement for *blood* alcohol concentration			
	Microgram alcohol per 100 mL of blood	**Per mille w/v [g alcohol per L of blood]**	**Per mille w/w [g alcohol per kg of blood]***	**Gram alcohol per 100 mL of blood**
2 000:1	80	0.80	0.75	0.080
2 100:1	84	0.84	0.79	0.084
2 300:1	92	0.92	0.87	0.092

[*] The specific weight of the total volume of blood is approximate 1.06
[**] 1 ‰ = 0.476 mg / L = 47.6 µg / 100 mL = 0.1 g / 210 L

Table 2 Negative effects at the levels of mass concentration

Breath mass concentration of alcohol mg/L	Blood mass concentration of alcohol g/L	Blood alcohol mass fraction ‰ (g/kg)	Negative effects [11]
0.101	0.21	0.20	➢ The ability to perceive moving sources of light deteriorates
> 0.152	> 0.32	> 0.30	➢ Subjectively noticeable drunkenness ➢ The ability to estimate depths is impaired ➢ Distances are no longer assessed accurately
> 0.253	> 0.53	> 0.50	➢ Objects appear further away than they actually are ➢ The eyes become less sensitive to red light ➢ Changing focus from one source of visual stimulation to another takes longer ➢ Speed of reaction and attentiveness quickly become significantly reduced
0.506	1.06	1.00	➢ The eyes' reactions to light and dark are considerably impaired ➢ The field of vision is considerably reduced ➢ Perception and assessment of depths and attentiveness are reduced by half ➢ Reaction times become even longer
0.658	1.38	1.30	➢ No driver is capable of driving
> 1.013	> 2.13	> 2.00	➢ First cases of fatal alcohol poisoning, particularly for those not accustomed to alcohol
1.519 - 1.772	3.19 - 3.72	3.00 - 3.50	➢ Swaying, slurring of speech; increasing lack of orientation and confusion ➢ Partial loss of memory in many cases ('blackouts')
1.772 – 2.532	3.72 - 5.32	3.50 - 5.00	➢ Fatal alcohol poisoning even for frequent drinkers

It had been scientifically proven that the following breath/blood alcohol concentrations have the following negative effects, presented in Table 2. The rate 2100:1 represents the rate blood/breath that was taken into account.

The concentration of ethanol present in the vapor phase above the liquid-water mixture depends on just two factors: the temperature of the mixture and the alcohol concentration in the liquid.

$$\gamma_{\text{air}} = \gamma_{\text{eth}} \cdot A \cdot e^{B \cdot t} \tag{1}$$

where:

γ_{air} is the mass concentration of ethanol in the vapor phase above the liquid-water mixture, mg/L;

γ_{eth} is the mass concentration of ethanol in the solution, g/L.

The following experimental coefficients A and B were established over several studies on the air/ethanol solution coefficient:

A = 0.041 45 [mg/L / g/L];
B = 0.065 83 [1 / °C];

Note that equation (1) is also referred to as Dubowski's formula [7]. In the case where t is equal to 34.00 °C, equation (1) becomes:

$$\gamma_{\text{air}} = 0.38866 \cdot \gamma_{\text{eth}} \tag{2}$$

Experimental system

For dissemination purposes several stages have been broken down step by step, as follows:

1st step

The breath alcohol analyzer Alcotest 9510 was calibrated by the LNE at the LNE laboratory using the LNE simulator system and the CRM prepared and certified by the LNE. The CRM prepared and used by the LNE is presented in Table 3.

Table 3 CRM prepared and used by the LNE

CRM N°	Mass concentration of alcohol in simulated breath	
	γ_{air}, mg/L	U, mg/L
1	0.200 0	0.003 3
2	0.400 0	0.003 3
3	0.700 0	0.003 3
4	1.500 0	0.003 3

2nd step

Applying the concept of traceability to breath alcohol measurements is not easy, but traceability has to provide qualitative results using analytical techniques used in calibration laboratories. In this regard a set of 7 standard solutions prepared by the LNE were used to calibrate the breath alcohol analyzer Alcotest 9510, using the ALCOCAL simulator system purchased by the INM. In order to draw the calibration curve using the INM simulator system, the following CRM (prepared by the LNE according to calibration certificates nos. M060126/01-07) were used – they are presented in Table 4.

Table 4 CRM prepared by the LNE and used by the INM

CRM N°	Mass concentration of alcohol in standard solution		Mass concentration of alcohol in simulated breath	
	γ_{eth}, g/L	U, g/L	γ_{air}, mg/L	U, mg/L
1	0.2573	0.0005	0.100 0	0.003 3
2	0.5146	0.0006	0.199 5	0.003 3
3	0.9005	0.0011	0.350 0	0.003 3
4	1.0292	0.0012	0.399 0	0.003 3
5	1.8011	0.0021	0.698 0	0.003 3
6	2.4444	0.0028	0.950 0	0.003 3
7	3.8595	0.0044	1.500 0	0.003 3

3rd step

The simulator system used by the INM to prepare and certify mass concentration standards of alcohol used in exhaled breath measurements consists of three main functional blocks:

A: Preparation system: the preparation system is used to generate the standard solution by gravimetric method, which consists of

- a calibrated mass balance, manufactured by Mettler Toledo, Max 310 g, d = 0.0001 g, according to calibration certificate no. 02.01-1111/2011,
- calibrated volumetric flasks,
- electronic densimeter, Anton Paar,
- ethanol reagent of 99.8 % purity, and
- distilled water of electrolytic conductivity 0.5 µS cm^{-1}.

B: Simulator system: the system used was ALCOCAL**,** manufactured by Dräger Safety AG & Co, KGaA Germany, calibration certificate no. 30089 from 06.09.2011 issued by the PTB Germany. Alcocal operates on the basis of enrichment of a carrier gas with ethanol vapor as the carrier gas is passed through an ethanol-in-water solution. The carrier gas used with Alcocal is air. A mass flow controller regulates the air mass flow rate internally. To determine the current mass flow rate the internal control circuit uses a sensor according to the heat transport principle, with the differential temperature being measured at a heated part of a capillary tube. Due to this principle the mass flow rate is independent of the air temperature and pressure. To prevent the inflow behavior of the mass flow controller from affecting the volume delivered, the flow rate upstream of the gas exposure process is regulated by a throttle valve set to the same dynamic pressure. Air leaving the mass flow controller passes first through the outer then through the inner of two incident vessels containing ethanol-in-water solutions and there is enriched with water and ethanol vapor according to the current fluid temperature and the associated vapor pressure. To improve the quality of measurement, a calibrated mass flow controller F-201AV-ABD-33-V was used, manufactured by Bronkhorst, according to the calibration certificate from 09.08.2011.

C: **Breath alcohol analyzer,** Alcotest 9510: The mass concentration of ethanol gas delivered by the simulator system was measured against the calibrated breath alcohol analyzer, Alcotest 9510, manufactured by Dräger Safety AG & Co KGaA, Germany, according to the test report issued by the LNE on 19.01.2012 (see Figure 1).

Seven standard solutions were prepared by the INM using the preparation system described above. These mass concentrations of alcohol are presented in Table 5.

4th step

The uncertainty budget was calculated for a number of 20 measurements against the Alcotest 9510 breath alcohol analyzer using the ALCOCAL system simulator and a standard solution of ethanol in distilled water having a mass concentration of (1.025 ± 0.162) g/L equivalent to a mass concentration of alcohol in simulated breath of 0.398 4 mg/L.

The indicated values were: 0.401; 0.401; 0.400; 0.401; 0.400; 0.400; 0.400; 0.400; 0.401; 0.400; 0.400; 0.400; 0.400; 0.398; 0.399; 0.400; 0.399; 0.400; 0.399; 0.399.

Table 5 CRM prepared and used by the INM

CRM N°	Mass concentration of alcohol in standard solution	Mass concentration of alcohol in simulated breath	
	γ_{eth}, g/L	γ_{air}, mg/L	u_c, mg/L
1	0.262 83	0.102	$7.05 \cdot 10^{-6}$
2	0.520 64	0.201	$2.77 \cdot 10^{-5}$
3	0.907 32	0.351	$8.40 \cdot 10^{-5}$
4	1.036 30	0.401	$1.10 \cdot 10^{-4}$
5	1.809 70	0.700	$3.34 \cdot 10^{-4}$
6	2.454 30	0.949	$6.15 \cdot 10^{-4}$
7	3.872 30	1.497	$1.53 \cdot 10^{-3}$

Figure 1 The calibration system used within the INM

Results and discussions

1st step

The calibration curve, using the LNE simulator system and the LNE standard solutions, was drawn in the LNE laboratory using the data presented in Table 6.

Table 6 LNE data using the LNE standard solutions

	LNE standard solutions			
mg/L	**0.200**	**0.400**	**0.700**	**1.500**
Alcotest 9510 indicated values, mg/L	0.204	0.400	0.723	1.556
	0.201	0.408	0.722	1.561
	0.202	0.409	0.721	1.562
	0.202	0.408	0.718	1.559
	0.202	0.409	0.720	1.559
	0.203	0.410	0.717	1.559
	0.204	0.410	0.717	1.558
	0.204	0.410	0.717	1.558
	0.203	0.406	0.716	1.558
	0.203	0.408	0.717	1.556
mean, mg/L	**0.202 8**	**0.407 8**	**0.718 8**	**1.558 6**
stdev, mg/L	0.001 0	0.003 0	0.002 5	0.001 9
stdev, %	0.51	0.74	0.35	0.12

2nd step

The calibration curve using the INM simulator system and the LNE standard solutions in the INM laboratory is presented in Figure 3. The data used for drawing the calibration curve is presented in Table 7.

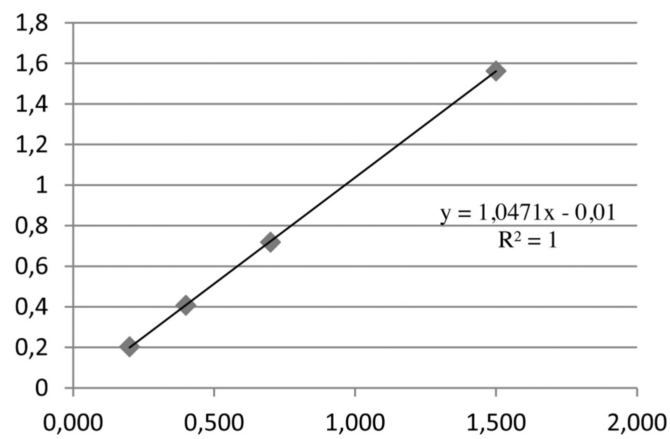

Figure 2 The calibration curve using LNE standard solutions and LNE simulator system

Table 7 INM data using the LNE standard solutions

	LNE standard solutions						
mg/L	**0.1000**	**0.1995**	**0.3500**	**0.3990**	**0.6980**	**0.9500**	**1.5000**
Alcotest 9510 indicated values, mg/L	0.094	0.196	0.354	0.407	0.723	0.981	1.585
	0.094	0.197	0.355	0.408	0.723	0.984	1.577
	0.092	0.196	0.356	0.410	0.724	0.990	1.586
	0.094	0.196	0.354	0.410	0.721	0.991	1.572
	0.093	0.197	0.355	0.410	0.722	0.990	1.584
	0.093	0.196	0.354	0.407	0.725	0.990	1.577
	0.093	0.196	0.355	0.408	0.722	0.985	1.579
	0.094	0.196	0.356	0.408	0.720	0.984	1.584
	0.093	0.196	0.354	0.409	0.722	0.985	1.581
	0.094	0.196	0.355	0.407	0.723	0.984	1.586
mean. mg/L	**0.0934**	**0.1962**	**0.3548**	**0.4084**	**0.7225**	**0.9864**	**1.5811**
stdev. mg/L	**0.0007**	**0.0004**	**0.0008**	**0.0013**	**0.0014**	**0.0035**	**0.0047**
stdev. %	**0.75**	**0.21**	**0.22**	**0.31**	**0.20**	**0.36**	**0.30**

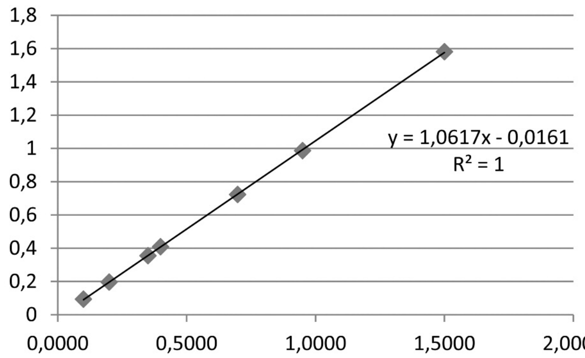

Figure 3 Calibration curve using LNE standard solutions and INM simulator system

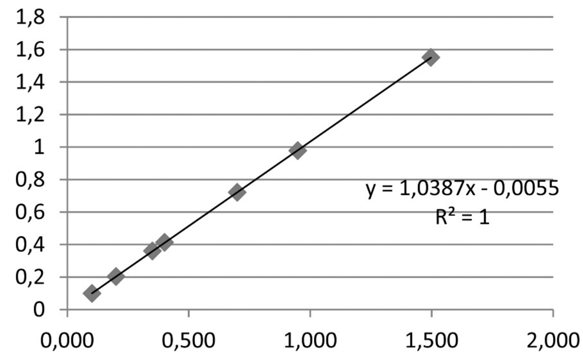

Figure 4 The calibration curve using INM standard solutions and INM simulator system

3rd step

The calibration curve using the INM simulator system and the INM standard solutions, in the INM laboratory. INM prepared a set of 7 solutions, mixtures of ethanol in distilled water, with the same mass concentrations of alcohol in simulated breath as those purchased from LNE. The data obtained is presented in Table 8. An example of the uncertainty budget using a mass concentration of alcohol 0.398 4 mg/L is described, calculated and presented in Table 12.

Recovery of the solutions

In order to calculate the recovery of the solutions, 7 standard solutions prepared by the LNE were used. The simulated mass concentrations of alcohol from breath exhaled were delivered by the simulator system presented above and, for every mass concentration, 10 measurements were made by the breath alcohol analyzer Alcotest 9510.

The recoveries of the standard solutions were calculated using formula (3) and the data are presented in Table 9.

$$R = \frac{\overline{\gamma_{measured}}}{\gamma_{CRM}} \qquad (3)$$

where:

- R is the recovery of the mass concentrations of alcohol, mg/L;
- $\overline{\gamma_{measured}}$ is the measurement of the mass concentration of ethanol, mg/L;
- γ_{CRM} is the mass concentration of ethanol of the certified reference material, mg/L.

Table 8 INM data using the INM standard solutions

INM standard solutions							
mg/L	**0.102**	**0.201**	**0.351**	**0.401**	**0.700**	**0.949**	**1.497**
Alcotest 9510 indicated values, mg/L	0.099	0.198	0.357	0.414	0.718	0.969	1.537
	0.097	0.205	0.360	0.412	0.718	0.975	1.548
	0.098	0.204	0.361	0.410	0.720	0.977	1.547
	0.102	0.205	0.360	0.411	0.727	0.971	1.553
	0.100	0.201	0.362	0.411	0.725	0.980	1.552
	0.101	0.204	0.360	0.416	0.717	0.978	1.548
	0.099	0.202	0.363	0.417	0.725	0.974	1.554
	0.099	0.203	0.360	0.418	0.721	0.985	1.550
	0.099	0.204	0.356	0.412	0.726	0.982	1.554
	0.097	0.201	0.364	0.415	0.715	0.981	1.562
mean. mg/L	**0.0991**	**0.2027**	**0.3603**	**0.4136**	**0.7212**	**0.9772**	**1.5505**
stdev. mg/L	0.0016	0.0022	0.0025	0.0028	0.0043	0.0050	0.0064
stdev. %	1.61	1.09	0.68	0.68	0.59	0.51	0.41
u_c , mg/L	**$9.824 \cdot 10^{-4}$**	**$1.096 \cdot 10^{-3}$**	**$1.148 \cdot 10^{-3}$**	**$1.227 \cdot 10^{-3}$**	**$1.625 \cdot 10^{-3}$**	**$1.902 \cdot 10^{-3}$**	**$2.682 \cdot 10^{-3}$**
U, mg/L (k=2)	**$1.96 \cdot 10^{-3}$**	**$2.19 \cdot 10^{-3}$**	**$2.30 \cdot 10^{-3}$**	**$2.45 \cdot 10^{-3}$**	**$3.25 \cdot 10^{-3}$**	**$3.80 \cdot 10^{-3}$**	**$5.36 \cdot 10^{-3}$**

Table 9 Recovery of the mass concentration of alcohol

LNE-CRM	CRM **0.1000**	R	CRM **0.1995**	R	CRM **0.3500**	R	CRM **0.3990**	R	CRM **0.6980**	R	CRM **0.9500**	R	CRM **1.5000**	R
Alcotest 9510 indicated values, mg/L	0.094	0.940	0.196	0.982	0.354	1.011	0.407	1.163	0.723	1.036	0.981	1.405	1.585	1.057
	0.094	0.940	0.197	0.987	0.355	1.014	0.408	1.166	0.723	1.036	0.984	1.410	1.577	1.051
	0.092	0.920	0.196	0.982	0.356	1.017	0.410	1.171	0.724	1.037	0.990	1.418	1.586	1.057
	0.094	0.940	0.196	0.982	0.354	1.011	0.410	1.171	0.721	1.033	0.991	1.420	1.572	1.048
	0.093	0.930	0.197	0.987	0.355	1.014	0.410	1.171	0.722	1.034	0.990	1.418	1.584	1.056
	0.093	0.930	0.196	0.982	0.354	1.011	0.407	1.163	0.725	1.039	0.990	1.418	1.577	1.051
	0.093	0.930	0.196	0.982	0.355	1.014	0.408	1.166	0.722	1.034	0.985	1.411	1.579	1.053
	0.094	0.940	0.196	0.982	0.356	1.017	0.408	1.166	0.720	1.032	0.984	1.410	1.584	1.056
	0.093	0.930	0.196	0.982	0.354	1.011	0.409	1.169	0.722	1.034	0.985	1.411	1.581	1.054
	0.094	0.940	0.196	0.982	0.355	1.014	0.407	1.163	0.723	1.036	0.984	1.410	1.586	1.057
Average, mg/L	**0.0934**	**0.934**	**0.1962**	**0.983**	**0.3548**	**1.014**	**0.4084**	**1.167**	**0.7225**	**1.035**	**0.9864**	**1.413**	**1.5811**	**1.054**
stdev	**0.0007**	**0.0070**	**0.0004**	**0.0021**	**0.0008**	**0.0023**	**0.0013**	**0.0036**	**0.0014**	**0.0021**	**0.0035**	**0.0050**	**0.0047**	**0.0031**
u_stdev	**0.00022**		**0.00013**		**0.00025**		**0.00040**		**0.00045**		**0.00111**		**0.00149**	

The zeta score and the trueness test - E_n numbers (expanded uncertainties of the assigned values and the obtained data) [10] were calculated using equations (4) and (5). The data are presented in Table 10 and were calculated using only the LNE CRMs; the means were calculated according to the indicated values (Alcotest 9510, breath alcohol analyzer) using the LNE simulator system and the INM simulator system. The deviations between the LNE CRMs and the indicated values by breath alcohol analyzer Alcotest 9510 (values mentioned in the LNE report issued in January 2012) were not taken into consideration due to the fact that two different simulator systems were used. The data presented in Table 11 were calculated using the LNE CRMs, the INM simulator system and the INM breath alcohol analyzer.

The recoveries of the mass concentrations of alcohol were calculated but these values were not taken into account in the following stages.

Taking into consideration all the data presented in Tables 6–9 it is obvious that the mass concentrations of alcohol prepared by the LNE have a better stability than those prepared by the INM.

The ALCOCAL simulator system used by the INM offers a very good stability of the temperature and, in this regard, a very good stability of mass concentrations of alcohol delivered.

Using the ALCOCAL simulator system is a very good way to reduce the standard uncertainty of mass concentration of alcohol in simulated breath.

$$z_{score} = \left| \frac{\bar{\gamma} - \gamma_{CRM}}{\sqrt{u_{\bar{\gamma}}^2 + u_{CRM}^2}} \right| \quad (4)$$

$$E_n = \left| \frac{\bar{\gamma} - \gamma_{CRM}}{\sqrt{U_{\bar{\gamma}}^2 + U_{CRM}^2}} \right| \quad (5)$$

Table 10 Zeta score and trueness test - E_n numbers

	Value, mg/L	**u,** mg/L	**RSU,** %		**Value,** mg/L	**u,** mg/L	**RSU,** %
	0.200 1 mg/L				0.400 1 mg/L		
	0.202 80	0.002 50	1.23		0.407 80	0.002 50	0.61
	0.199 5 mg/L				0.399 0 mg/L		
	0.196 20	0.001 93	1.00		0.408 40	0.004 79	1.17
Z_{score}	**2.089**			Z_{score}	**0.111**		
E_n	**1.045**			E_n	**0.055**		
	0.699 8				1.555 0		
	0.719 00	0.004 35	0.61		1.558 60	0.004 68	0.30
	0.698 0				1.500 0		
	0.722 50	0.013 31	1.84		1.581 10	0.045 93	2.90
Z_{score}	**0.250**			Z_{score}	**0.487**		
E_n	**0.125**			E_n	**0.244**		

Table 12 An example of the uncertainty budget for mass concentration of alcohol from breath exhaled

No	Quantity	Value	Standard uncertainty, u(x)	Probability distribution
The final value of mass concentration of alcohol from simulated breath is: $(0.399\,90 \pm 0.001\,81)$ mg/L or $(0.399\,90 \pm 0.001\,81)$ mg/L , (*k*=2)				
Note: 20 measurements (the displayed values were between 0.398 and 0.401 mg/L, the average value was 0.399 9 mg/L)				
1	**Uncertainty budget due to the alcohol breath analyzer, type Alcotest 9510, configured with Infrared and Electrochemical sensors- IR & EC →** $\gamma_{Breath\ Analyzer} = \gamma_{air} \cdot f_{repetability} \cdot f_{rezolution} \cdot f_{liniarity}$			
	$\gamma_{Breath\_Analyzer}$, mg/L	0.398 420	$u_{\gamma_{Breath_{Analyzer}}} = \sqrt{u^2_{c(\gamma_{air})} + u^2_{f_{repeatability}} + u^2_{f_{rezolution}} + u^2_{f_{liniarity}} + u^2_{f_{recovery}}} = 9.03 \cdot 10^{-4}$	Gaussian
	γ_{air}, mg/L (see 1.1)	0.398 420	$u_{c(\gamma_{air})} = \sqrt{\left(\frac{\partial\gamma_{air}}{\partial\gamma_{alcohol}}\right)^2 \cdot u^2_{\gamma_{alcohol}} + \left(\frac{\partial\gamma_{air}}{\partial\gamma_t}\right)^2 \cdot u_t^2} = 2.70 \cdot 10^{-4}$	Gaussian
	$f_{repeatability}$, mg/L	1	$u_{f_{repeatability}} = \sqrt{\frac{s^2}{n}} = \sqrt{\frac{0.000\,788^2}{20}} = 1.76 \cdot 10^{-4}$	Gaussian
	$r_{esolution}$, mg/L	1	$u_{f_{rezolution}} = \frac{0.001}{2 \cdot \sqrt{3}} = \frac{0.001}{\sqrt{12}} = 2.89 \cdot 10^{-4}$	Rectangular
	$l_{inearity}$, mg/L	1	$u(x_{pred}, y) = \frac{\sqrt{\frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n-2}}}{m} \cdot \sqrt{\frac{1}{N} + \frac{1}{n} + \frac{(\frac{\sum_{i=1}^{N} y_i}{N} - \bar{y})^2}{m^2\left((\sum_{i=1}^{n} x_i^2) - \left((\sum_{i=1}^{n} x_i)^2\right)/n\right)}} = =7.92 \cdot 10^{-4}$	Rectangular
1.1	**Uncertainty budget for mass concentration of alcohol from simulated breath delivered by the wet-simulator system →** $\gamma_{air} = \gamma_{alcohol} \cdot A \cdot e^{B \cdot t}$			
	$\gamma_{alcohol}$, g/L (see 1.1.1)	1.025 110	$u_c(\gamma_{alcohol}) = \sqrt{\left(\frac{\partial\gamma_{alcohol}}{\partial V}\right)^2 \cdot u^2(V) + \left(\frac{\partial\gamma_{alcohol}}{\partial m}\right)^2 \cdot u^2(m)} = 1.67 \cdot 10^{-4}$	Gaussian
	$t_{34\,(CE)}$, °C	34.00	$u_t = 1{,}00 \cdot 10^{-2}$ (according to the calibration certificate)	Gaussian
1.1.1	**Uncertainty budget of the solution of alcohol in distilled water →** $\gamma_{alcohol} = \frac{m_{(alcohol)}}{V_{(total)}}$			
	m, g (see 1.1.1a)	5.135 820	$u_c(m) = \sqrt{u_c^2(m_{weighted}) + u_c^2(purity) + u_c^2(decanting) + u_c^2(evaporation) + u_c^2(density)} = 3.88 \cdot 10^{-3}$	Gaussian
	V, L (see 1.1.1b)	5.00	$u_c(vol) = \sqrt{u_c^2(vol_{dilatation\ of\ flask}) + u_c^2(vol_{dilatation\ of\ flask\ due\ to\ temperature}) + u_c^2(vol_{water\ dilatation})} = 1.50 \cdot 10^{-3}$	Gaussian
1.1.1a	**Uncertainty budget for mass alcohol →** $m = m_{weighed} \cdot f_{decanting} \cdot f_{evaporation} \cdot f_{purity} \cdot f_{density}$			
	$m_{weighed}$, g (see 1.1.1a*)	5.135 820	$u_c(m_{\mathrm{weighted}}) = \sqrt{\bar{s}^2(\Delta m) + u_c^2(CE\_balance)} = 5.29 \cdot 10^{-6}$	Gaussian
	f_{purity}, g	1	$u_c(P) = \frac{\frac{(1-0.998)}{2} \cdot m_{weighted}}{\sqrt{4.5}} = 2.42 \cdot 10^{-3}$	Semi-triangular
	$f_{decanting}$, g	1	$u_c(decanting) = \frac{m_{al} \cdot \frac{V_{lost\ alcohol}}{V_{total\ weighed}}}{\sqrt{4.5}} = \frac{m_{weighed} \cdot \frac{0.05(\mathrm{cm}^3)}{40\ (\mathrm{cm}^3)}}{\sqrt{4.5}} = 3.03 \cdot 10^{-3}$	Semi-triangular
	$f_{evaporation}$, g	1	$u_c(evaporation) = \frac{a}{\sqrt{4.5}} = \frac{\frac{0.004}{2}}{\sqrt{4.5}}$ mg = 3,93 · 10^{-5}	Semi-triangular
	$f_{density}$, g	1	$u_c(density) = 1 \cdot 10^{-5}\ \mathrm{g/cm}^3 = 1.00 \cdot 10^{-5}$	Gaussian
1.1.1b	**Uncertainty budget for volume →** $V = V_{water\ (flask)} \cdot f_{dilatation\ of\ flask\ due\ to\ the\ temperature} \cdot f_{dilatation\ of\ water\ due\ to\ the\ temperature}$			
	$V_{\mathrm{water\ (flask)}}$, cm^3	5 000	$u_c(vol_{dilatation\ of\ flask}) = \frac{u_{flask}}{\sqrt{6}} = \frac{1.2}{\sqrt{6}} = 4.90 \cdot 10^{-1}$	Triangular
	$f_{\mathrm{dilatation\ of\ flask\ due\ to\ the\ temperature}}$, cm^3	1	$u_c(vol_{dilatation\ of\ flask\ due\ to\ temperature}) = \frac{V \cdot \alpha_{Pyrex} \cdot \Delta t}{\sqrt{2}} = 7.07 \cdot 10^{-2}$	Arcsine
	$f_{\mathrm{dilatation\ of\ water\ due\ to\ the\ temperature}}$, cm^3	1	$u_c(vol_{water,t}) = \frac{V_{water} \cdot \alpha_{water} \cdot \Delta t}{\sqrt{2}} = 1{,}41$	Arcsine
1.1.1a*	**Uncertainty budget for weighed mass alcohol →** $m_{weighed} = m_{alcohol(CE)} \cdot f_{repetability(of\ weighed\ mass)}$			
	$m_{alcohol\ CE\_balance}$, g	5.135 820	$u_{m_{alcohol\_CE(balance)}} = 1.72 \cdot 10^{-6}$	Gaussian
	$f_{repeatability}$ of weighed mass, g	1	$\bar{s}(\Delta m) = \sqrt{\frac{\sum_{i=1}^{n-1} \Delta^2 m_i}{n(n-1)}} = 5.00 \cdot 10^{-6}$	Gaussian

Table 11 Zeta score and trueness test - E_n numbers

	Value, mg/L	**u,** mg/L	**RSU,** %		**Value,** mg/L	**u,** mg/L	**RSU,** %
	0.1000	0.001 65	1.65		0.199 5	0.001 65	0.83
	0.093 4	0.003 32	3.55		0.196 2	0.001 93	0.98
$\boldsymbol{R}$, mg/L	0.934 0	0.015 3	1.64	$\boldsymbol{R}$, mg/L	0.983 5	0.008 1	0.82
Z_{score}	**1.780**			Z_{score}	**1.299**		
E_n	**0.890**			E_n	**0.650**		
	0.350 0	0.0016 5	0.47		0.399 0	0.001 65	0.41%
	0.354 8	0.002 49	0.70		0.408 4	0.004 79	1.17%
$\boldsymbol{R}$, mg/L	1.013 7	0.004 8	0.47	$\boldsymbol{R}$, mg/L	1.023 6	0.004 3	0.42%
Z_{score}	**1.609**			Z_{score}	**1.854**		
E_n	**0.805**			E_n	**0.927**		
	0.698 0	0.001 65	0.24		0.950 0	0.001 65	0.17
	0.722 5	0.013 31	1.84		0.986 4	0.020 16	2.04
$\boldsymbol{R}$, mg/L	1.035 1	0.002 5	0.24	$\boldsymbol{R}$, mg/L	1.038 3	0.002 1	0.21
Z_{score}	**1.827**			Z_{score}	**1.799**		
E_n	**0.914**			E_n	**0.900**		
	1.5000	0.001 65	0.11				
	1.581 1	0.045 93	2.90				
$\boldsymbol{R}$, mg/L	1.054 1	0.001 5	0.14				
Z_{score}	**1.765**						
E_n	**0.882**						

***Note 1*:** The uncertainty due to the deviation (bias) was not taken into account because the mean of the indicated values did not exceed the limits of the interval. In the event that these limits are exceeded, it shall take a rectangular distribution into consideration.

***Note 2*: Breath alcohol analyzer "zero function" uncertainty** is not taken into account because the breath alcohol analyzer carries out an automatic adjustment of the zero value before and after each measurement.

***Note 3*:** Due to the fact that the breath alcohol analyzer requests for analysis a sample of 1.2 L of air and it does NOT take into account more than the last cm^3 (which represents the required volume for analysis and corresponds to the alveolar air as demonstrated by several research studies), it is NOT necessary to take the uncertainty due to the plateau into account.

***Note 4*:** The uncertainties due to the recoveries of the standard solutions have not been taken into consideration at this stage.

Acknowledgment

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JCGM 106:2012

A new guidance document on measurement uncertainty and conformity assessment

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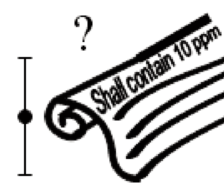
In 1997 a Joint Committee for Guides in Metrology (JCGM) was formed, chaired by the Director of the BIPM – the International Bureau of Weights and Measures. The JCGM has two Working Groups: WG1 is focussed on maintenance and support of the GUM (*Evaluation of measurement data - Guide to the expression of uncertainty in measurement* [1]); WG2 supports the VIM (*International vocabulary of metrology – Basic and general concepts and associated terms* [2]). Activities of the WGs include the production of associated guidance documents, necessary revisions and supplemental materials to promote the broad use of the GUM and the VIM.

In 2012, the JGGM member organizations approved JCGM 106:2012 "*Evaluation of measurement data – The role of measurement uncertainty in conformity assessment* " [3], which has since been published by the OIML as OIML G 1-106:2012. The new guide assumes that a GUM-compliant measurement has been made and addresses the question of deciding conformance of the measured quantity with a specified requirement, typically defined by a range of permissible values.

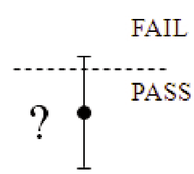
Some measurements, including many of those performed by standards laboratories, do not involve conformance decisions. In calibrating a gauge block, for example, the metrologist is interested in a best estimate of the length of the block, with a minimum associated standard uncertainty for a given level of cost and effort. Once the length has been measured and the calibration certificate is complete, the measurement is finished.

Other measurements, by contrast, often involve comparison of the measurement result with another result, a standard value, a specified requirement or legal limit, or perhaps a value written in a contract. A digital voltmeter, for example, might be legally required to have an error of indication of no greater than 10 µV when measuring a 10 V reference voltage standard. JCGM 106 provides guidance on how to take measurement uncertainty into account when deciding whether such comparisons are satisfactory – that is, whether the measured property conforms with a specified requirement.



It was fashionable at one time, particularly in legal matters, to assert that there was no uncertainty of measurement and that a prescribed limit had already taken into account any concerns of measurement error (as it was then known). Apart from the faulty logic, such an approach does not encourage changes in methods that may lead to a lowering of uncertainty and the approach also raises the risk of costly decision mistakes.

With the first publication of ISO/IEC 17025 [4], evaluation of measurement uncertainty became required, and its reporting became mandatory when measurement results were being assessed against limits (5.10.3.(c) " ... information on uncertainty is needed in test reports ... when the uncertainty affects compliance to a specification limit;"). Thus measurement uncertainty is now closely associated with conformity to limits, which motivated JCGM-WG1 to turn its attention to this important aspect of measurement uncertainty.



The approach to evaluating measurement uncertainty taken by the original authors of the GUM and maintained by JCGM-WG1 in its preparation of further guides and, at present, the revision of the GUM itself, is that a measurement result can be expressed in terms of a probability density function (pdf), the form of which gives the value to be reported (usually the mean of the distribution) and a coverage interval in which the value of the measurand is believed to lie with a stated probability.

The pdf encodes and conveys belief in the possible values of a measured quantity. Strategies for obtaining relevant information used in assigning a pdf for the measurand depend on the measurement problem and the data available, but the package of approaches is generally called 'Bayesian', after the 18th century English cleric who is credited with providing the first description of the inductive probabilistic reasoning that later led Laplace to write down what is now known as Bayes' Theorem.

Comparing a measurement result with a specified limit provides a good example of this probabilistic approach, as one of the often-asked questions is, "what is the probability that I will make a mistake if I accept/

reject this item based on my measurement result". In the world of product manufacture and process control, the probability of accepting an item when it should have been rejected is known as 'consumer's risk', and the probability of falsely rejecting the item is known as 'producer's risk'. Each of these outcomes can be modelled in terms of the measurement result and associated measurement uncertainty, and appropriate acceptance limits can be chosen so as to balance the risks. Methods for calculation of these risks are a central focus of JCGM 106.

Simply deciding to accept an item whose measured value is within a prescribed 'tolerance limit', and otherwise rejecting the item, shares the risk between consumer and producer. The probability of false acceptance or false rejection is equal (assuming a symmetrical pdf) for a measurement exactly at the tolerance limit. Such a 'decision rule' is called simple acceptance in JCGM 106, and is often accompanied by a requirement that the expanded measurement uncertainty be no greater than a specified value[1].

Another decision rule described in JCGM 106 is called 'guard banding'. If the consequences arising from the two errors are different, life and death in some health or forensic situations, a second limit, offset from the tolerance limit, is often prescribed (an 'acceptance limit') which defines a 'guard band'. The use of a guard band reduces the probability of error for one or other of the risks and in doing so increases the probability of the other, less seriously consequential, risk.

The various decision rules are illustrated in Figure 1.

The following example illustrates use of a guarded acceptance decision rule.

In the testing of race horses for administration of sodium bicarbonate, a so-called "milk shake" is administered, which raises the concentration of carbon dioxide in the blood. The limit published in the rules of racing is that a horse must not be presented for racing with greater than 36 mmol L^{-1} 'total carbon dioxide' (TCO_2). TCO_2 is measured by an electrochemical gas analyser with a standard uncertainty of about 0.2 mmol L^{-1}. In Australia, a prosecution is not brought until the measured concentration is greater than 37 mmol L^{-1}. The example is therefore one of Figure 1 (b) with T_u = 36 mmol L^{-1} and A_u = 37 mmol L^{-1}. Knowing that the standard uncertainty of the measurement is 0.2 mmol L^{-1} and assuming a normal distribution for the pdf of the measurement result, the odds that a sample with a measured concentration of 37 mmol L^{-1}, causing the trainer of the horse to be liable to prosecution, actually being legal at 36 mmol L^{-1} or less, are about 3.5 million to one against. In contrast, a horse with 37 mmol L^{-1} TCO_2 in its blood has a one in two chance of getting away with this transgression (for the actual uncertainty budget and calculations see [5]).

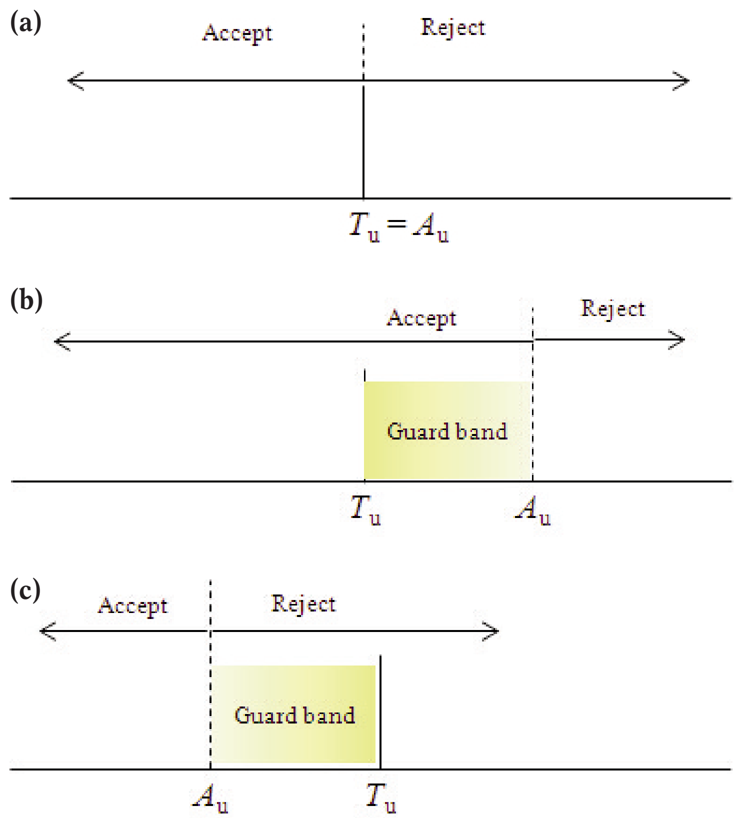


Figure 1: Acceptance or rejection of an item on the basis of a measurement result. T_u is an upper tolerance limit with which a measured property must comply (the true value must be less than T_u). A_u is the upper acceptance limit of the measured value. (a) shared risk (or simple acceptance) where the tolerance and acceptance limits are equal; (b) guarded acceptance, which reduces the producer's risk; (c) guarded rejection, which reduces the consumer's risk. The nomenclature follows from guidance document JCGM 106:2012.

[1] The shared-risk principle is traditionally used in legal metrology when, for instance, the indication of a measuring instrument is required to be within maximum permissible errors, with an additional requirement that the error of the verification method is less than one fifth of the maximum permissible error of the instrument being verified.

As a member organization of the JCGM, the OIML publishes JCGM documents as they are completed. These publications may be freely downloaded from the OIML website: http://www.oiml.org/publications.

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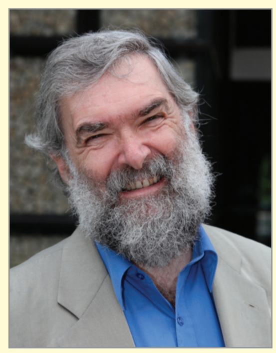


D. Brynn Hibbert

BIML Note: OIML TC 3/SC 5 *Conformity assessment* has a project (p2) to develop an OIML Document on the expression of uncertainty in measurement in legal metrology applications. A first committee draft (1CD) had been circulated in 2009, but work on the project was suspended in view of the development of JCGM 106. A second committee draft (2CD) utilizing JCGM 106 is expected this year.

HISTORY OF SCALES

Part 7: The world of load cells in the technology of scales and weighing

ING. WOLFGANG EULER, HENNEF/SIEG, and
HEINZ WEISSER, BALINGEN

The next two parts of the series "Weights, scales and weighing through the ages", Parts 7 and 8, deal with load cells and strain-gauge technology (SGT). Following that, electronic weighing technology will be covered.

By way of introduction, here is a simple initial consideration: In the case of the mechanical beam balance, the weight of a known mass is the reference force. When measuring force with a strain-gauge load cell, the electrical change in the resistance, which is produced through the geometric change of a loaded metallic body, is the measure for the reference force.

The "Mass/force measurement" figures clearly show the difference between the two measuring processes. While in the "mass weighing", the unknown weight is determined by the addition of weights until equilibrium is reached – or, expressed another way, in the case of mechanical scales, the weight of a known mass is the reference force – in the case of the strain gauge load cell, weight is determined by the deformation of a piece of metal with ohmic resistors attached as a Wheatstone bridge (Sir Charles Wheatstone, 1802–1875, English scientist). As already explained in detail, force measurement is an analogue process, i.e. the deformation of the metal body also results in an analogue deformation of the ohmic resistor attached to the metal. The stronger the deformation, the stronger the measurement signal of the resistor to the weighing module. In the weighing module the A/D (analogue/digital) conversion then takes place.

Today, "digital" load cells are frequently spoken of. This designation is not correct. The force absorption is still analogue; then, however, a conversion from analogue to digital signals takes place directly on or in the load cells (see diagrams below).

Since 1955 Hottinger Baldwin Messtechnik GmbH (HBM) in Darmstadt – as the first German company – has been particularly successfully involved in the development and manufacture of strain gauges and load cells; this is also the case for Bizerba in Balingen since 1980. Out of the initially limited applications of strain-gauge technology, a breadth of application which can barely be taken in and which stretches across almost all technical fields and peripheral areas has developed up to the present day. In particular, strain-gauge load cells led to quite a fundamental change in weighing. Just as the Chronos scales of 1883 from the town of Hennef an der Sieg ended weighing by hand after many thousands of years and the age of automatic weighing began, so did weighing with weights (mass) almost exclusively end – after the invention of scales about 7 000 to 10 000 years ago – with the invention of the strain-gauge load cell.

Weighing technology today

Metrology has always had a special place in the technology of scales and weighing. The reasons for this are that

- scales have been one of the oldest measuring instruments of all, dating back 7 000 to 10 000 years,
- the accuracy required is considerably higher than for other measuring instruments,
- weighing technology is subject to legislation in many cases,
- scales regulated and controlled the flow of money and goods in the past as they do today, and
- without scales, no orderly economic cycle would be possible.

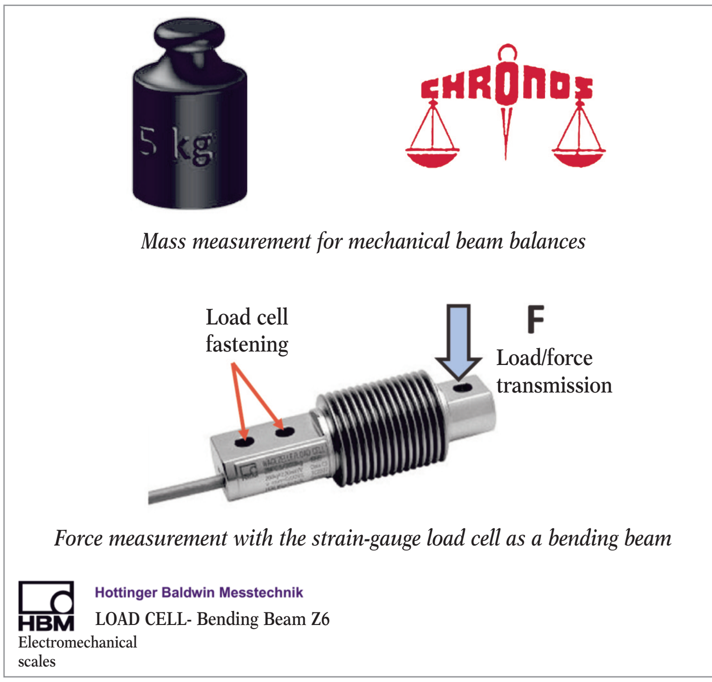


Figure 1: Mass measurement and force measurement

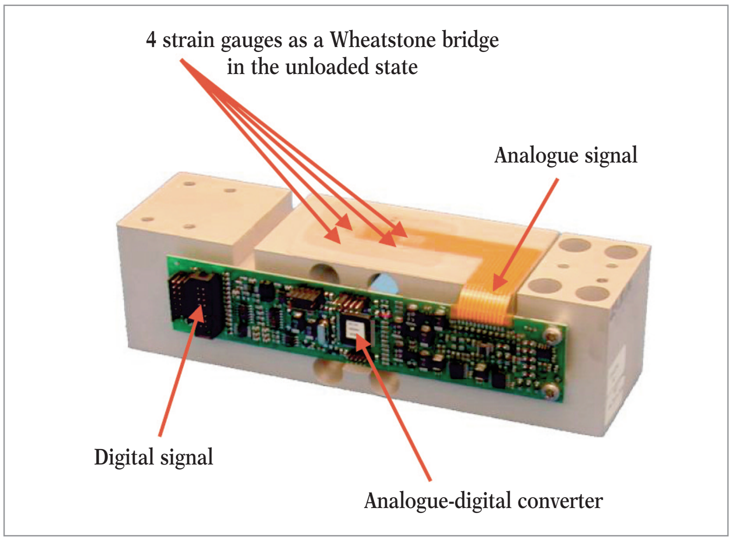


Figure 2: Strain-gauge load cell as a flexible link Bizerba

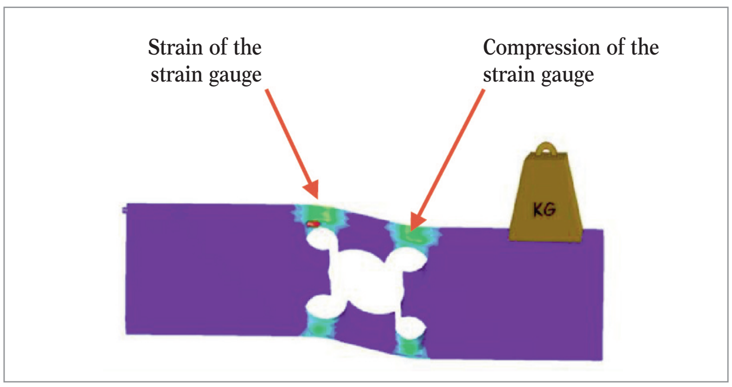


Figure 3: Schematic drawing of the deformation of the load cell metal body

Technical change in weighing technology

Weighing technology, similar to the clock industry, has experienced a large and special structural change in the last few decades. Where lever systems for transformation, transmission and totalization did the work in the past, today we almost exclusively find strain-gauge load cells.

It has to be noted, however, that apart from strain-gauge load cells, there are also other measuring procedures for force absorption, EMFC (electromagnetic force compensation load cells) and vibrating string technology.

The measuring chain

The strains to be measured with strain gauges are usually very small. As a result of this, the changes in resistance are also very low and cannot be measured in a direct way, for instance with an ohmmeter. It is thus necessary to integrate the strain gauge into a measuring chain, whereby an exact determination of the change in resistance of the strain gauge becomes possible.

The first link in the measuring chain is formed by the strain gauges themselves. They change the mechanical "strain" or the "compression" into an electric "change in resistance".

This first link in the chain is a measuring circuit (here a Wheatstone bridge circuit), which consists of four strain gauges. Both the strain gauges and the measuring circuit are (in the physical sense) passive links. Energy must be supplied to them to receive a usable electric signal. This auxiliary energy is taken from a separate source.

Generally, a constant electric voltage is used, sometimes also a constant electric current. When the resistance of the strain gauge changes as a result of a strain, then the bridge circuit is no longer symmetrical, it becomes unbalanced and yields a bridge output voltage which is proportional/analogue to the unbalancing of the bridge.

The second link in the measuring chain is an amplifier, which amplifies the bridge output voltage to an amount sufficient to run display units. In the case of a linearly operating amplifier, its output voltage is proportional to the amplifier's input voltage (that is the bridge output voltage) and thus, in turn, to the strain to be measured.

The third link in the measuring chain is formed by the display. It transforms the output signal of the amplifier into a form accessible to human senses. In the most simple case the pointer deflection of a voltmeter or the series of digits of a digital measuring instrument serves to show the measurement value. Today's amplifiers also contain analogue/digital conversion and thus allow both device types to be connected, either alternatively, or as shown in the example in Fig. 4.

The above description of the measuring chain only roughly sketches the links which are absolutely necessary. In practice the measuring chain often has various extensions through additional components, such as selector switches, filters, peak value memory, limit switches, control output devices and others.

Instead of the display units, it is also possible to connect up the usual data processing systems and to use the various options they provide. ■

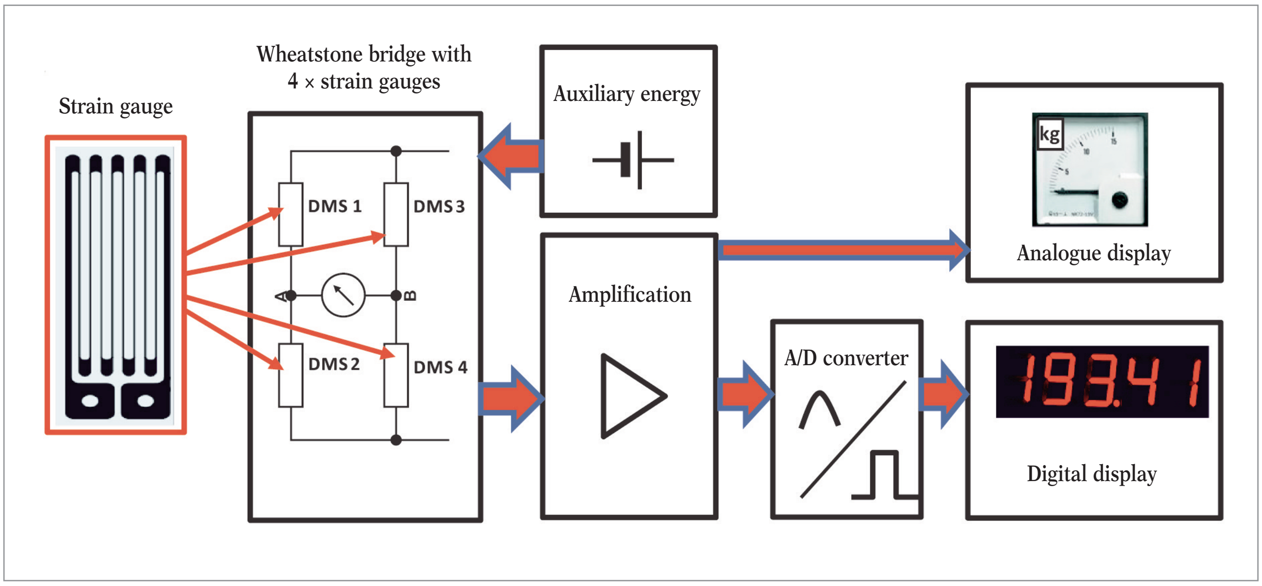


Figure 4: Analogue/digital conversion

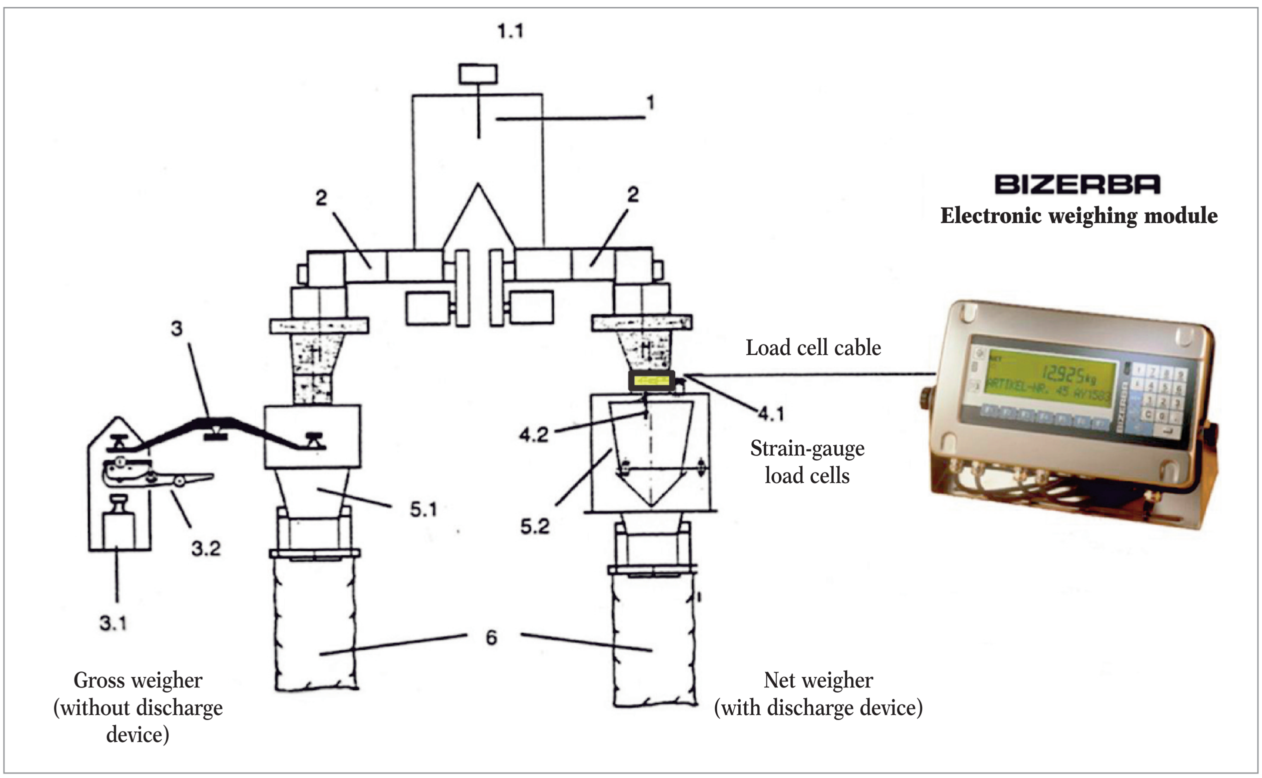


Figure 5: Comparison of a gross with a net weigher with and without discharge device. Basic set-up of automatic scales with mass measurement in the case of mechanical beam balances (No. 5.3) or in the case of electro-mechanical scales with strain-gauge load cells (No. 5.4.1). The other numerical terms will be explained at a later point, when the corresponding scales will also be dealt with and described.

HISTORY OF SCALES

Part 8: Load cells and measuring with strain gauges

Ing. Wolfgang Euler, Hennef/Sieg, and
Heinz Weisser, Balingen

In August 2001, WELMEC (European Cooperation in Legal Metrology) issued guidelines for the mounting and application of load cells. If the mounting guidelines correspond to the WELMEC requirements, no further drawings of constructions for the mounting of the load cells are necessary. If the internal fittings of the load cells are, however, not in line with the WELMEC guidelines, then corresponding drawings must be created for the individual cases of application. **The following information does not comprise all the pages of the Guide** (WELMEC 2.4, Issue 2/2001).

In the mounting versions of the following load cell designs, several examples are shown of how strain-gauge load cells are used and mounted as bending beams (F = force introduction). In Part 5 even a load container for larger filling quantities (a hopper) was depicted. In accordance with WELMEC 2.4, a mounting drawing is no longer necessary for several designs, if they are in line with the WELMEC guidelines.

Looking back at the first steps for measuring with strain-gauge load cells

The usual way of determining parts of scales, machines, buildings, vehicles, aircraft, etc. (generally speaking, of components), is based on the strength calculation. The quantity used for evaluating the stress of the material is the mechanical tension which the material is exposed to. A feasible method for the experimental determination of material stress is founded on a discovery that was made as long ago as 1678 by the English scientist Robert Hooke (1635–1703). He found a connection between material stress and the deformation dependent on it. This deformation, also called ***"expansion"***, also appears on the surface of objects and is thus accessible to measurement.

Acknowledgements

- Hoffmann, K.: Eine Einführung in die Technik des Dehnungsmessstreifens Hottinger Baldwin Messtechnik GmbH, Darmstadt
- Bizerba GmbH & Co. KG, Balingen
- Kochsiek, M.: Handbuch des Wägens

Metallic strain gauges

In the second half of the 1930s an effect was remembered that Charles Wheatstone mentioned in his first publication in 1843 which was about the bridge circuit he invented. It is the change in the resistance of an electric conductor through the influence of mechanical stress.

William Thomson (1824–1905, after 1892 Lord Kelvin) goes into this more in a paper published in 1856.

That more than 80 years were to pass until the actual real use of the aforementioned invention, has several reasons related to technical improvements and the further development of the system described above.

In the United States in around 1938 two people pursued – almost simultaneously, but independently of each other – the idea of using the "Thomson Effect" for measuring purposes. In California it was Edward E. Simmons. He made a woven material out of silk thread as the warp and thin resistance wire and in this way created an electric force measuring device. In Massachusetts Arthur Claude Ruge worked on seismology at the Massachusetts Institute of Technology and wanted to measure the stress – caused by simulated earthquake tremors – on the model of an earthquake-resistant water tank.

Ruge carried out his last experiment with a thin resistance wire, by sticking this to a thin piece of cigarette paper and having thicker connections on the ends.

To be able to investigate the properties of this artefact, he stuck it to a bending beam and compared its measurement values with those of a conventional strain measuring instrument. He found good agreement and a linear connection between the strain and the readings over the whole measurement range, for positive as well as for negative strain (compression), in addition to a good zero point stability.

Thus the "electric resistance strain gauge with bonded grid", to give it its full name, was invented. In his very first attempt, he had found the form that the gauge is still basically in today.

With this series of articles the authors would like to pass on their knowledge about scales and metrology to the next generation, which is still being taught and trained and which will in turn take on responsibilities in companies in the future. The authors have also donated half of their fees to the Carl-Reuther-Berufskolleg (a vocational college) in Hennef and to the Deutsche Müllerschule (German Milling School) in Braunschweig.

The authors would apreciate receiving any tips and suggestions, especially from manufacturers of scales and millwrights, based on their experience.

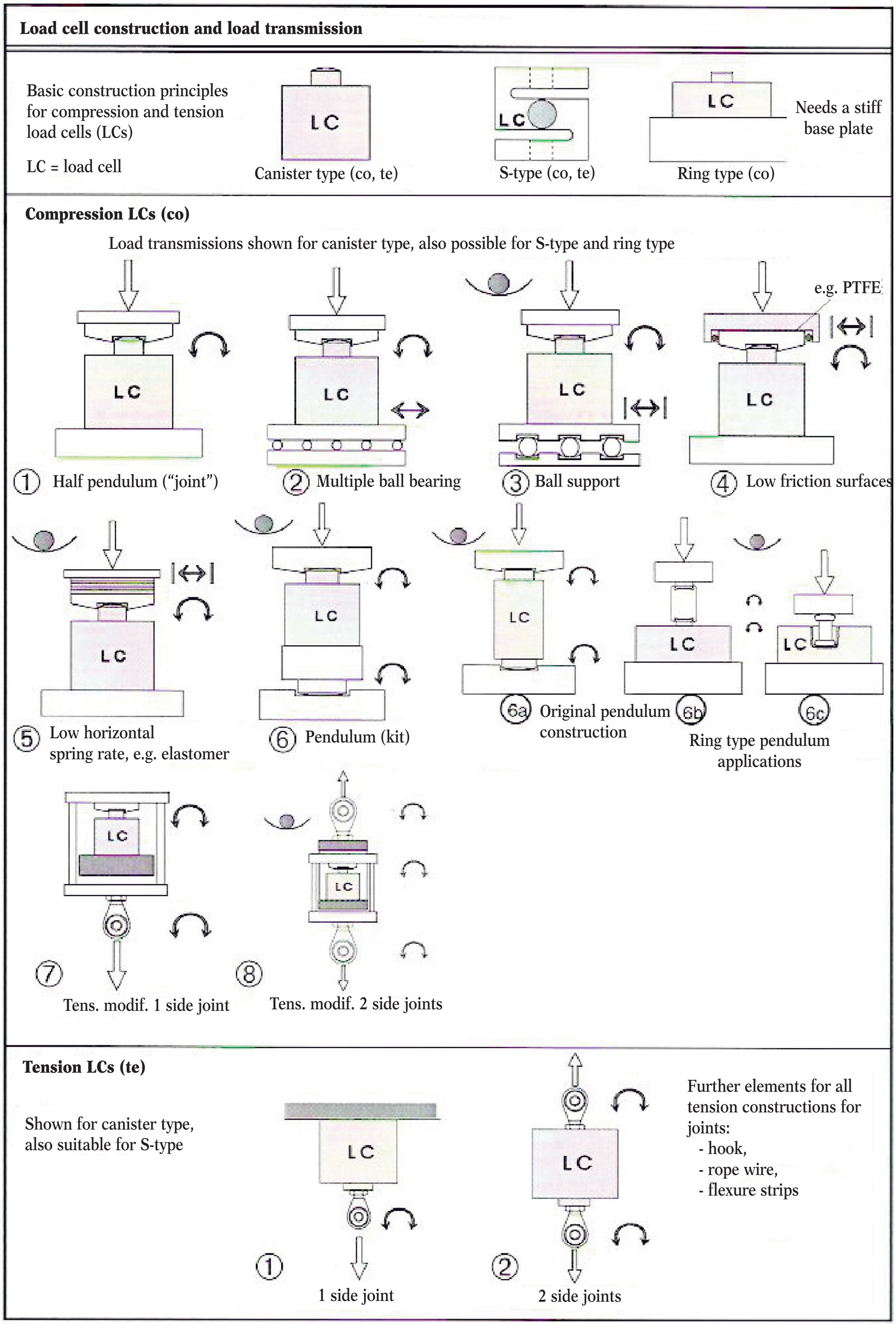


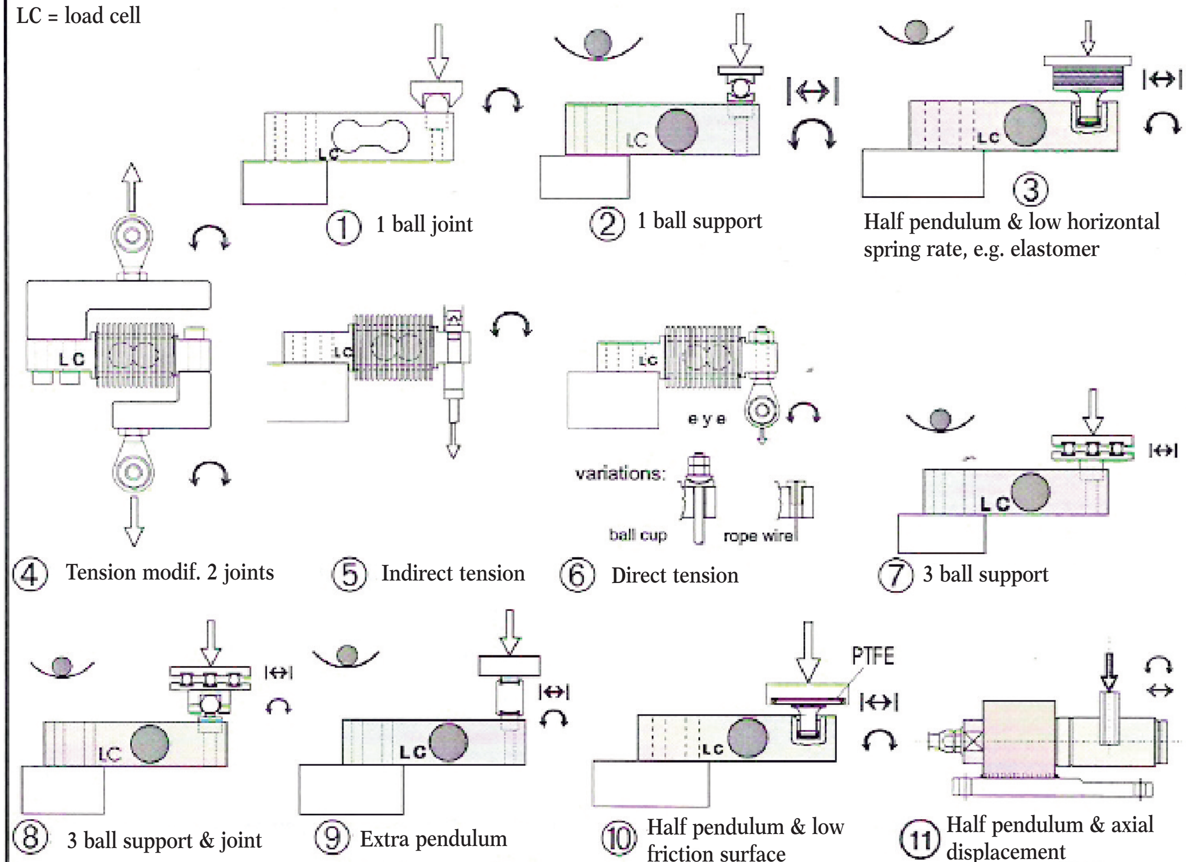
Figure 1: Schematic drawings of compression and tension LCs (Source: WELMEC Guide 2.4:2001)

Load cell construction and load transmission

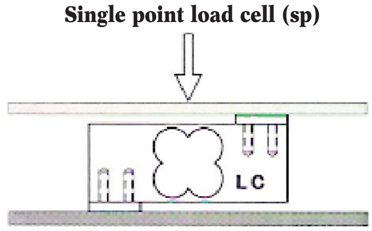
The load transmission device is independent of the encapsulation, potting or housing and the mounting at the fixed end shown below

Beam load cell - Cantilever beam (be)
Double bending beam and shear beam load cell

LC = load cell

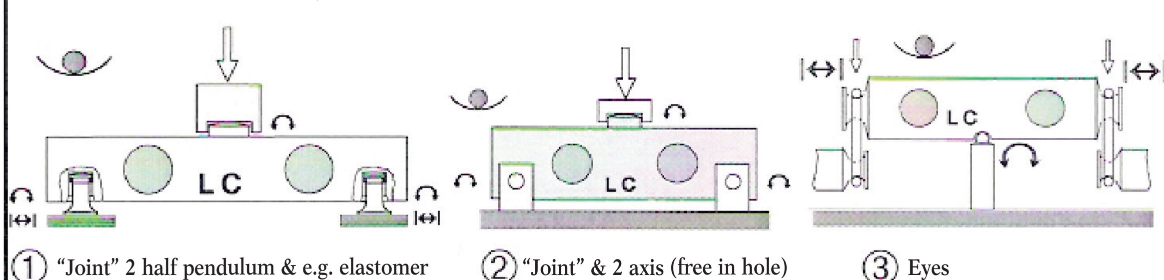


Single point load cell (sp)



The single point load cell has no degree of freedom for horizontal displacement or inclination, using more than one load cell in a load receptor uncoupling elements are necessary. The load transmissions 1 to 10 for the beam load cells may be applied.
Maximum platform dimensions may be mentioned in the test certificate or the type approval certificate.

Double ended beam load cell (de)



Constructions with fixed clamping at the two ends need some elasticity of the supporting construction for minimum displacement and inclination.

Figure 2: Load cell construction and load transmission (Source: WELMEC Guide 2.4:2001)

Ruge's crucial idea, in which he differed from Simmons, was that of attaching the measuring wire to a foil backing, creating an independent measuring instrument which is easy to handle, and which could be stuck to any surface. It was very thin and light, needed no pressure force and caused practically no reaction, so that measurements also became possible on thin objects. Through the application of electric amplifiers, static and dynamic measurements were also possible.

Even the first prototypes of the ***strain gauge*** proved to be superior to all the ***strain measuring devices*** commonly used until then.

The history of strain-gauge load cells as bending beams will end for now. In the next parts of this series, the various types of weighing instruments, e.g. receiving scales, loading scales, weighing and bagging machines, proportioning weighers, checkweighers and price indicating scales will be reported on. Strain-gauge load cells will inevitably be dealt with again regarding their function and resolution as well as the maximum permissible errors. ■

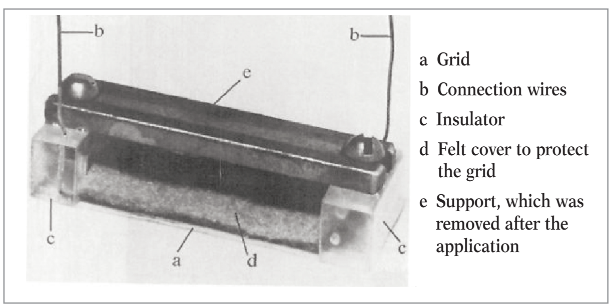


Figure 4: First mass-produced strain gauge

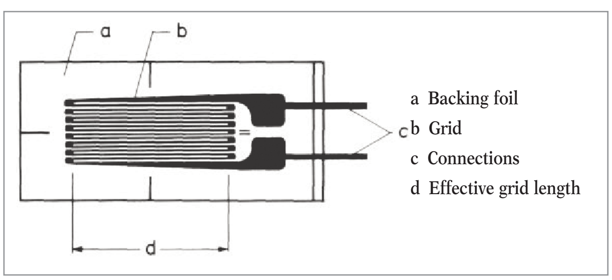


Figure 5: Characteristic design of a strain gauge

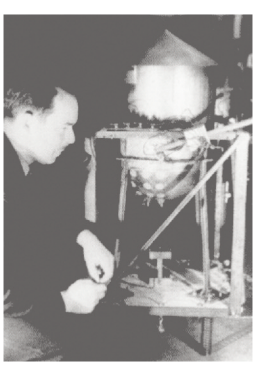


Figure 6: Arthur Claude Ruge, the inventor of the strain gauge, performing his measurements

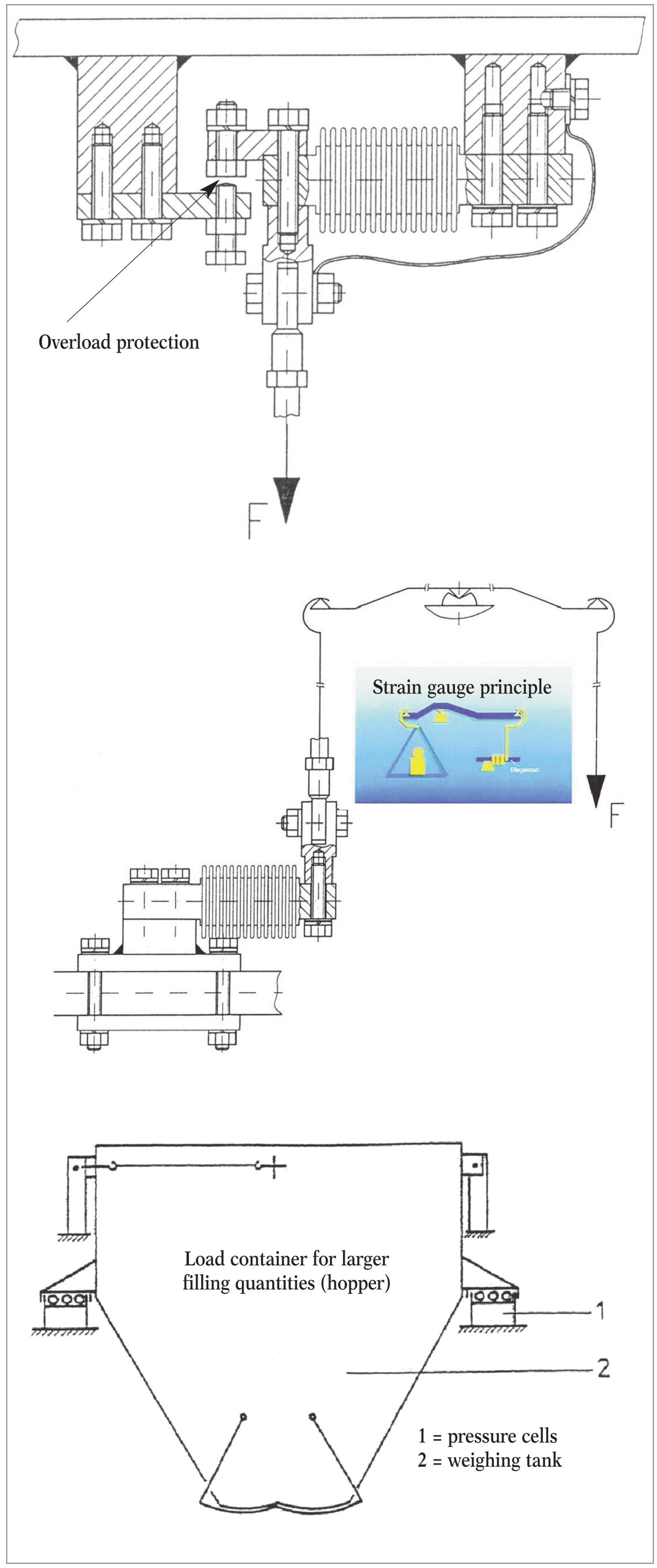


Figure 3: Examples of LC internal fittings

CONSUMER PROTECTION

Weighing scales re-checker unit: a tool to boost public awareness and encourage participation in legal metrological control

Rifan Ardianto, M.Si
Head of Section of Cooperation – Directorate of Metrology, Indonesia

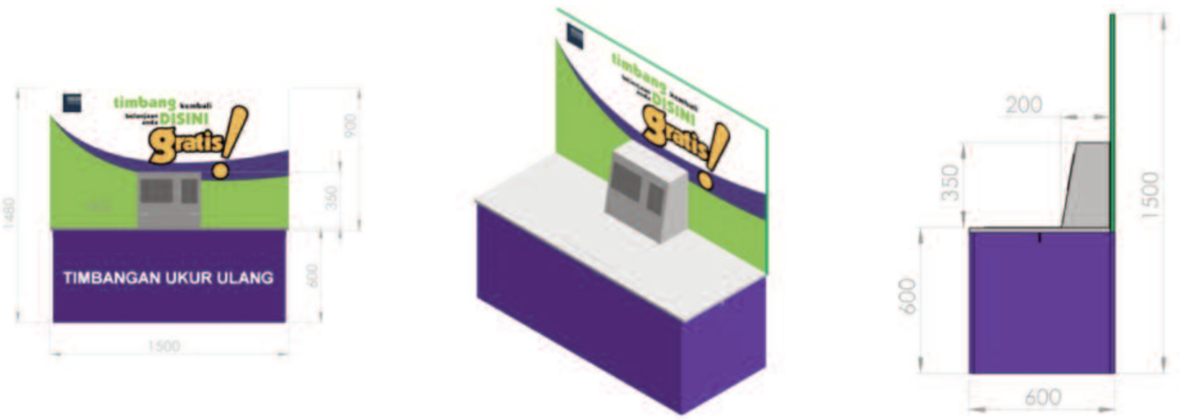
Over the last five years, domestic trade in Indonesia – similarly to other countries – has been faced with tough challenges. The economic crisis has had effects worldwide, including effects on the dynamics of trade exchanges within many economies, in particular in developing countries. Prices have risen sharply both for food and other basic products such as fuel and electricity.

This condition has made things difficult for society as a whole, but particularly for the lower to middle class sector. In considering this society with a low income level and a high demand level, the situation gives rises to problems in terms of the cost of living. But, from the point of view of consumer protection, it poses a challenge in terms of minimizing losses for society. Weights and measures become the "X" factor in determining the level of losses in terms of accuracy. Inaccurate measurements in scales or in the weighing operation during trading causes unfair trade transactions – for example, a customer might be sold 900 g but charged for 1 kg. He ends up bearing the cost of higher prices and runs a greater risk of being defrauded.

For example, national rice consumption per person in 2010 was an average 6.9 kg per month or 4.4 USD equivalent. If, therefore, there is say a 6 % rate of inaccurate measurement or weighing then the loss per person will be 0.4 kg per month. This figure becomes significant when scaled up to the total national rice consumption which is, on average, 1 656 million kg per month. This translates to a financial loss caused by inaccurate measurement of up to 96 million kg per month, or 612 173 USD equivalent per month.

In the light of these facts, the government has to take action to protect the interests of consumers, which is its responsibility. The above example shows that even for a small inaccurate measurement occurring in everyday individual trade transactions, the impact quickly becomes nationally statistically significant and can potentially prejudice consumers.

Insufficient government resources are the main problem in providing adequate consumer protection, in particular for legal metrology. In 2012, there were only 801 verification officers to cover 240 million people and ±1.9 million km^2 of land. It is recognized that it is not easy to correctly protect public interests. The scope of consumer protection activities (particularly in the field



Specification for the standard (certified) weighing instrument:

a. Capacity: ≥ 30 kg
b. Readability: 5 – 100 g
c. Complementary: printer for printing result

Figure 1: Dimensions and specifications of the weighing scales re-checker unit

a) A consumer buys 2 kg of rice at a traditional market. The measuring instrument used by the trader is a non-automatic weighing instrument (weighing balance class IV).

b) She feels the weight of the purchased rice is lighter than it should be.

c) She goes to the weighing scales re-checker unit (above) and checks the weight of the purchased rice (below).

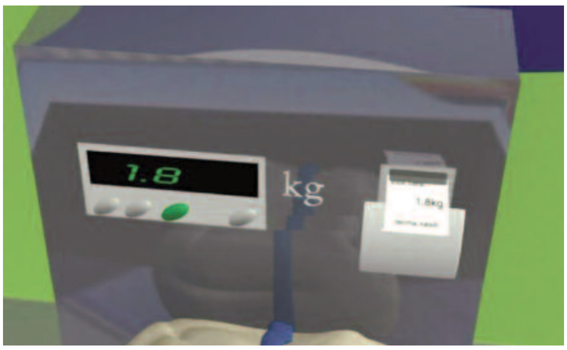


Figure 2: Weighing scales re-checker unit in operation at a traditional market

of legal metrology) is very wide due both to the large number of consumers to be protected, the wide range of regulated measuring instruments to be monitored, and also the prevailing economic situation over the last five years – namely rising prices, which has become a major issue.

It is therefore not sufficient to rely on government resources, but the public's participation must be ensured in monitoring the use of measuring instruments in trading activities. Increasing public awareness of legal metrology requirements also encourages the users of measuring instruments to actively make efforts to verify that the instruments meet the appropriate requirements. The low level of awareness of users in verifying the measuring instruments they come into contact with has in fact actively generated more work for the verification officers, who have to travel to rural areas and even to traditional country markets to carry out verification activities.

Indonesia's traditional markets play a special role in the Indonesian economy, as they closely concern many cultural, geographical, and traditional aspects of the Indonesian people. Traditional markets play a role in supporting local employment, maintaining price stability of basic commodities, empowering small to middle sized enterprises, improving social welfare, and increasing local revenue. Traditional markets in Indonesia are among the most frequently visited – as many as 25 times per month – and in total over 7 million measuring instruments (in particular weighing instruments) are used in trading activities in these markets.

Realizing the potential of these markets and improving consumer protection by ensuring commercial fairness, standards, and legal metrology, helps to transform the image of the traditional markets into honest markets which are always able to offer the best products at the best price.

The weighing scales re-checker unit, called the *Timbangan Ukur Ulang*, is one of the means provided by the government in its aim to introduce elements of consumer protection in the traditional markets and hence boost consumer awareness. The weighing scales re-checker unit is a tool consisting of a standard (certified) weighing instrument which is installed in the traditional markets to allow consumers to recheck the items they have purchased (excluding pre-packaged products) - see Figure 1.

The operation of the weighing scales re-checker unit is managed by the traditional market duty manager. There may also be a mediator in the event of a dispute or conflict between a consumer and a trader related to the measurement result of a measuring instrument used to perform a commercial transaction in the market. The duty manager should have knowledge of the relevant regulations, how to use a measuring instrument in the

d) She finds that the weight of the purchased rice is only 1.8 kg and not 2 kg.

e) She informs the market duty manager and explains her complaint concerning the alleged inaccurate measurement. The duty manager accompanies her to the trader at whose kiosk she bought the rice.

f) The duty manager first inspects the verification mark and its validity on the trader's measuring instrument. This shows that the verification mark still exists and that the date on the verification mark is still valid.

g) After checking the verification mark, he discovers that there is something wedging the weighing scales, which causes them to not function correctly.

h) Realizing this, the trader adds to the customer's 1.8 kg of rice and apologizes for her inadvertence.

i) Ultimately, both the trader and the consumer feel satisfied. The consumer gets the right quantity and the trader gains trust from the customers.

Figure 2: Weighing scales re-checker unit in operation at a traditional market (cont'd)

proper way, how to identify an infringement, how to identify measuring instruments that do not comply with requirements, and how to handle complaints and disputes.

Illustrations a–i in Figure 2 show a weighing scales re-checker unit in operation at a traditional market. They show how to build market trust; legal metrology should play a role as a referee in handling conflicts between consumers and traders in the use of measuring instruments. The weighing scales re-checker is a tool to help consumers monitor measurement results and become a part of the legal metrological control process.

Placing the weighing scales re-checker unit in public places where trading transactions are carried out is part of the establishment of the Fair Traditional Market (i.e. markets with orderly measurement) which was started in 2010. The Fair Traditional Market is an effort to provide an assurance that all measuring instruments

Figure 3: The Indonesian Minister of Trade and the Vice Minister of Trade launched the weighing scales re-checker unit at the traditional markets in Kota Batam and Kota Balikpapan

used for trade in traditional markets meet the appropriate requirements. Currently there are 91 Fair Traditional Markets and annually, 30 more traditional markets will become Fair Traditional Markets. Also, 30 weighing scales re-checker units have so far been distributed to 30 Fair Traditional Markets.

The program to establish Fair Traditional Markets and to place weighing scales re-checker units at traditional markets is aimed at increasing consumer protection and at promoting the legal metrology aspect of commercial transactions to boost public awareness. Thus, by participating in legal metrological control and rendering it efficient, the public will be an inherent part of legal metrology activities.

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REGIONAL NEWS

MERCOSUR: Mercado Común del Sur

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Departamento de Análisis y Laboratorio
Dirección de Metrología Legal
LATU

Dirección de Metrología Legal

1 Introduction

MERCOSUR stands for *Mercado Común del Sur* or Southern Common Market. The Member States are Argentina, Brazil, Paraguay, Uruguay and Venezuela (incorporated in August 2012).

Member States share values related to environmental protection, sustainable growth, democracy, freedom, and human rights. They are committed to consolidating democracy, ensuring justice, combating poverty, encouraging economic growth and promoting social equity.

MERCOSUR's objectives are:

- the free circulation of goods, services and productive factors between Member States through, among other measures, the elimination of customs barriers and other non-tax restrictions;
- the establishment of a common external tariff, the adoption of a common commercial policy in relation to other States or groups of States, and the coordination of positions in regional and international commercial and economic forums;
- the coordination of macroeconomic and sector policies between Member States in regards to external commerce, agriculture, industry, taxation, currency, transport, communication and other areas, to ensure adequate conditions of competence between Member States; and
- the commitment of Member States to harmonize their legislation in pertinent areas so as to strengthen the integration process.

2 Legal metrology in MERCOSUR

One of the bodies of the MERCOSUR structure is the Common Market Group (*Grupo Mercado Común* – GMC).

There are various working groups in the Common Market Group, called sub-groups. The Metrology Committee belongs to Sub-Group No. 3 *Technical Regulations and Conformity Assessment* (Sub-Grupo de Trabajo No. 3 *Reglamentos Técnicos y Evaluación de la Conformidad*), and works on harmonizing legislation through resolutions that are then incorporated into each Member State's legislation.

Meetings are held quarterly in the country holding the Pro-tempore Presidency, which is changed every six months.

In the beginning, pre-packaged products were dealt with by the Food Committee. After pre-packaged products were incorporated into the Metrology Committee, this Committee had three "sub-committees": *Measuring instruments*, *Prepackaged products* and *Scientific metrology*. Today, only two of these groups (*Measuring instruments* and *Prepackaged products*) operate in this scope. *Scientific metrology* works with SIM (*Interamerican Metrology System*).

To date there are more than twenty resolutions concerning pre-packaged products, three resolutions concerning measuring instruments and three general resolutions on legal metrology.

The 2012 work plan includes revising the three general resolutions on legal metrology:

- GMC Res. No. 57/92 – *Documents for measuring instrument type approval application*;
- GMC Res. No. 51/97 – *General criteria for legal metrology*; and
- GMC Res. No. 60/05 – *Measuring instrument type approval certificate*.

For resolutions to be effective and really put into practice, a mutual recognition agreement in the scope of legal metrology between Member States should be reached.

3 Measuring instruments in MERCOSUR

The first measuring instrument to be regulated by MERCOSUR was material measures of length for general use, in 1992, through GMC Res. No. 53/92. This resolution was revised, and substituted by GMC Res. No. 51/99 in 1999. The next instrument was mercury in glass clinical thermometers with a maximum device, GMC Res. No. 18/00, substituted in 2001 by GMC Res. No.

17/01, followed by taximeters also in 2001 (GMC Res. No. 15/01).

All these resolutions have been incorporated into the Argentine, Brazilian, Paraguayan and Uruguayan legislation.

In spite of there being three resolutions for measuring instruments, at the time they were approved no measures were taken by this committee as to how to go about mutual recognition of type approval and initial verification, so measuring instruments with type approval in one Member State might be re-tested in another.

To prevent the same thing happening with non-automatic weighing instruments, a document was drafted on mutual recognition of tests performed on these instruments once the resolution is approved.

From the end of 2000 through 2008, the *Measuring instruments* group worked on regulations for fuel dispensers and non-automatic weighing instruments; no resolutions have been approved for these instruments as no consensus has yet been reached. Since 2008 work has concentrated on a resolution for load cells.

Simultaneously, in Uruguay, the need to regulate other measuring instruments arose. As this was not initially planned in the Metrology Committee's work plan, in 2009, 2010 and 2011 liquid in glass clinical thermometers, clinical electrical thermometers with maximum device and non-invasive automated sphygmomanometers were regulated nationally. Training took place with the help of other Member States and SIM.

4 Prepackaged products in MERCOSUR

The first regulations for pre-packages date back to MERCOSUR's origins in 1992.

In 2011, a revision of the resolution related to the labeling requirements of pre-packaged products was started (GMC Res. Nº 22/02) . One of the requirements in MERCOSUR is that the nominal quantity be expressed on the principal display panel. In spite of this requirement being present in OIML R 79:1997, there are many pre-packaged products that do not comply with this.

Also, in MERCOSUR the term "pre-measured products", and not "pre-packaged products" has been defined. These terms and definitions are being analyzed to determine which is best fitted to MERCOSUR's needs.

Simultaneously this year, the resolution on *Quantity of product in pre-packages*" (GMC Res. No. 07/08) is in revision because in the present sampling plan both consumer and producer risk are too high; one of the greatest challenges is to find a solution for checking the amount of product in pre-packages when the batch size is less than 100 pre-packages. This situation is quite frequent. In some cases, the actual batch sizes are small, for example retailers that buy bulk commodities and fraction only what they expect to sell per day or per week, due to restricted storage space. In other cases lot sizes are small for imported pre-packages which may only be destined for a restricted population group. These small inspection lots are usually a sub-lot of a regular sized batch in the country of origin. In the first case, one option could be to check all the prepackages in the inspection lot. The second case is more complex, specially when it is necessary to consider every individual tare weight.

It is necessary to learn to discern when a common position must be reached, and when this is not necessary, as with special products that are specific to a small region.

5 The future

In the future, all aspects of legal metrology should be regulated by resolutions which include mutual recognition agreements, so that the metrological aspects do not prevent MERCOSUR from reaching its objective of free circulation of goods. ■

www.mercosur.int

Metrology

BIPM

OIML

World Metrology Day
20 May
www.worldmetrologyday.org

Press release

WORLD METROLOGY DAY 2013

Measurements in daily life

Release:

May 20 is World Metrology Day, commemorating the anniversary of the signing of the Metre Convention in 1875. This treaty provides the basis for a coherent measurement system worldwide.

The theme chosen for 2013 is ***Measurements in daily life***. In the course of a typical day it is surprising how often measurements come into play, whether (among many possible examples) checking the time, purchasing food or produce, filling up a vehicle with fuel, or undergoing a blood pressure check.

These, and countless other activities in daily life, require measurements of one sort or another. Yet accurate measurements are taken for granted nowadays. Not surprisingly, most people are unaware that in the background there is a worldwide community specializing in metrology, the science of measurements, making sure it all works. Everybody depends on this community doing its job, and doing it well.

Across the world, national metrology institutes continually advance measurement science by developing and validating new measurement techniques at whatever level of sophistication is needed. They also participate in comparisons coordinated by the Bureau International des Poids et Mesures (BIPM) to ensure the reliability of measurement results worldwide.

Many measuring instruments are controlled by law or are subject to regulatory control, for example the scales used to weigh goods in a shop, instruments to measure environmental pollution, or meters used to bill energy. The International Organization of Legal Metrology (OIML) develops international Recommendations, the aim of which is to align and harmonize requirements for these types of instruments worldwide.

World Metrology Day recognizes and celebrates the contribution of all the people that work in intergovernmental and national organizations throughout the year on behalf of all.

Further information, including a message from the Directors,
posters, and a list of events, is available at
www.worldmetrologyday.org

Contact: wmd@worldmetrologyday.org

Notes for Editors:

World Metrology Day is an annual event during which more than 80 countries celebrate the impact of measurement on our daily lives.

This date was chosen in recognition of the signing of the Metre Convention on 20 May 1875, the beginning of formal international collaboration in metrology. Each year World Metrology Day is organized and celebrated jointly by the **International Bureau of Weights and Measures** *(BIPM) and the* **International Organization of Legal Metrology** *(OIML) with the participation of the national organizations responsible for metrology.*

The international metrology community which works to ensure that accurate measurements can be made across the world endeavors to raise awareness each World Metrology Day through a poster campaign and **web site**. *Previous themes have included topics such as measurements for safety, for innovation, and measurements in sport, the environment, medicine and trade.*

About the BIPM

The signing of the Metre Convention in 1875 created the BIPM and for the first time formalized international cooperation in metrology. The Convention established the International Bureau of Weights and Measures and laid the foundations for worldwide uniformity of measurement in all aspects of our endeavors, historically focusing on and assisting industry and trade, but today just as vital as we tackle the grand challenges of the 21st Century such as climate change, health, and energy. The BIPM undertakes scientific work at the highest level on a selected set of physical and chemical quantities. The BIPM is the hub of a worldwide network of national metrology institutes (NMIs) which continue to realize and disseminate the chain of traceability to the SI into national accredited laboratories and industry.

About the OIML

In 1955 the International Organization of Legal Metrology (OIML) was established as an Intergovernmental Treaty Organization in order to promote the global harmonization of legal metrology procedures with the Bureau International de Métrologie Légale (BIML) as the Secretariat and Headquarters of the OIML. Since that time, the OIML has developed a worldwide technical structure whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations.

DEVELOPING COUNTRIES

Announcing the

Fifth OIML Award for Excellent contributions from Developing Countries to legal metrology

Background

Many developing countries suffer from a lack of resources for the operation of a sound legal metrology system. Although these resources cannot be provided by the OIML, the Organization supports initiatives for the development of legal metrology. To highlight the importance of metrology activities in developing countries, and to provide an incentive for their improvement, in 2009 the OIML established an Award for "*Excellent contributions from developing countries to legal metrology*".

This Award is intended to raise the awareness of, and create a more favorable environment for legal metrology and to promote the work of the OIML. The Award intends: "*to acknowledge and honor new and outstanding activities achieved by individuals, national services or regional legal metrology organizations contributing significantly to legal metrology objectives on national or regional levels.*"

How can candidates be proposed?

Nominations may be made by any individuals or organizations concerned with legal metrology, including the individual or organization seeking the Award.

Nominations should be sent to Ian Dunmill at the BIML and must contain facts, documents and arguments explaining why the candidate deserves the Award. The closing date is 1 July 2013.

Selection procedure

The BIML will prepare a list of candidates highlighting the importance of the achievements, and will rank the applications. The Award winner will be selected by the CIML President and announced at the 48th CIML Meeting in October 2013.

Selection criteria

The criteria which will be used to assess the candidates' contribution or achievement will include:

- its significance and importance;
- its novelty;
- its attractiveness and adaptability for other legal metrology services.

The OIML Award

The Award will consist of:

- a Certificate of Appreciation signed by the CIML President;
- a token of appreciation, such as an invitation to make a presentation of the Award-winning achievement at the next CIML Meeting or OIML Conference at the OIML's expense;
- an engraved glass award trophy.

Further information

For more details, please contact:

Ian Dunmill
BIML Assistant Director
ian.dunmill@oiml.org

Past Awards

2012 - Loukoumanou Osséni (Benin)

2011 - José Antonio Dajes (Peru)
and
Juan Carlos Castillo (Bolivia)

2010 - Thai Legal Metrology Service

2009 - Mr. Osama Melhem (Jordan)

OIML Systems

Basic and MAA Certificates registered 2012.12–2013.02

Information: www.oiml.org section "OIML Systems"

The OIML Basic Certificate System

The *OIML Basic Certificate System for Measuring Instruments* was introduced in 1991 to facilitate administrative procedures and lower the costs associated with the international trade of measuring instruments subject to legal requirements. The System, which was initially called "OIML Certificate System", is now called the "OIML Basic Certificate System". The aim is for "OIML Basic Certificates of Conformity" to be clearly distinguished from "OIML MAA Certificates".

The System provides the possibility for manufacturers to obtain an OIML Basic Certificate and an OIML Basic Evaluation Report (called "Test Report" in the appropriate OIML Recommendations) indicating that a given instrument type complies with the requirements of the relevant OIML International Recommendation.

An OIML Recommendation can automatically be included within the System as soon as all the parts - including the Evaluation Report Format - have been published. Consequently, OIML Issuing Authorities may issue OIML Certificates for the relevant category from the date on which the Evaluation Report Format was published; this date is now given in the column entitled "Uploaded" on the Publications Page.

Other information on the System, particularly concerning the rules and conditions for the application, issue, and use of OIML Certificates, may be found in OIML Publication B 3 *OIML Basic Certificate System for OIML Type Evaluation of Measuring Instruments* (Edition 2011) which may be downloaded from the Publications page of the OIML web site. ■

The OIML MAA

In addition to the Basic System, the OIML has developed a *Mutual Acceptance Arrangement* (MAA) which is related to OIML Type Evaluations. This Arrangement - and its framework - are defined in OIML B 10 (Edition 2011) *Framework for a Mutual Acceptance Arrangement on OIML Type Evaluations*.

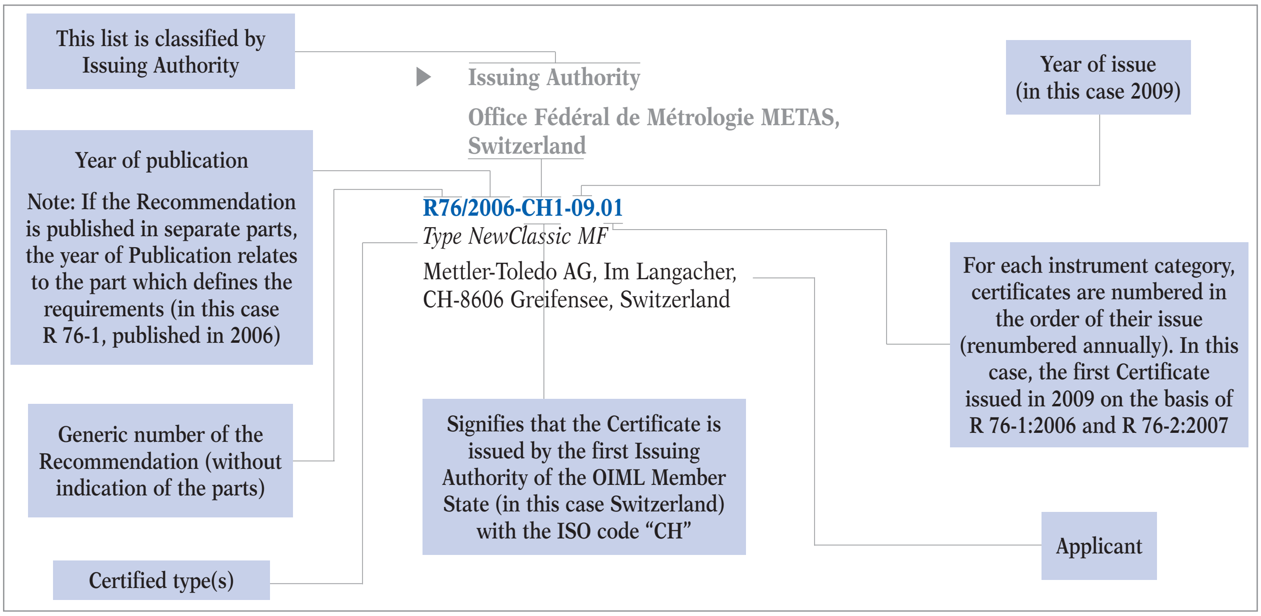
The OIML MAA is an additional tool to the OIML Basic Certificate System in particular to increase the existing mutual confidence through the System. It is still a voluntary system but with the following specific aspects:

- increase in confidence by setting up an evaluation of the Testing Laboratories involved in type testing,
- assistance to Member States who do not have their own test facilities,
- possibility to take into account (in a Declaration of Mutual Confidence, or DoMC) additional national requirements (to those of the relevant OIML Recommendation).

The aim of the MAA is for the participants to accept and utilize MAA Evaluation Reports validated by an OIML MAA Certificate of Conformity. To this end, participants in the MAA are either Issuing Participants or Utilizing Participants.

For manufacturers, it avoids duplication of tests for type approval in different countries.

Participants (Issuing and Utilizing) declare their participation by signing a Declaration of Mutual Confidence (Signed DoMCs). ■



INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Water meters intended for the metering of cold potable water
Compteurs d'eau destinés au mesurage de l'eau potable froide

R 49 (2003)

▶ Issuing Authority / *Autorité de délivrance*

NMi Certin B.V.,
The Netherlands

R049/2003-NL1-2012.04
Water meter intended for the metering of cold potable water, model "OPTIFLUX x300; OPTIFLUX x000F + IFC300y", class 1 and 2

Krohne Altometer, Kerkeplaat 12, NL-3313 LC Dordrecht, The Netherlands

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Water meters intended for the metering of cold potable water and hot water
Compteurs d'eau destinés au mesurage de l'eau potable froide et de l'eau chaude

R 49 (2006)

▶ Issuing Authority / *Autorité de délivrance*

Laboratoire National de Métrologie et d'Essais,
Certification Instruments de Mesure, France

R049/2006-FR2-2008.05 Rev. 2
Electronic water meter CONTAZARA type CZ-SJ intended for the metering of cold potable water

CONTAZARA S.A, Carretera Castellon km 5.5,
ES-50720 Sarragosse, Spain

R049/2006-FR2-2009.01 Rev. 2
Compteurs d'eau types 171 A et 171 B

Hydrometer GmbH, Industriestrasse 13,
DE-91522 Ansbach, Germany

R049/2006-FR2-2010.03 Rev. 1
Electronic water meters CONTAZARA type CZTJ DN 50, 65, 80, 100, 125, 150, 200

CONTAZARA S.A, Carretera Castellon km 5.5,
ES-50720 Sarragosse, Spain

▶ Issuing Authority / *Autorité de délivrance*

NMi Certin B.V.,
The Netherlands

R049/2006-NL1-2012.03
Water meter intended for the metering of cold potable water and hot water, model "WATERFLUX 3070", class 1 and 2.

Krohne Altometer, Kerkeplaat 12, NL-3313 LC Dordrecht, The Netherlands

R049/2006-NL1-2012.03 Rev. 1
Water meter intended for the metering of cold potable water and hot water, model "WATERFLUX 3070", class 1 and 2.

Krohne Altometer, Kerkeplaat 12, NL-3313 LC Dordrecht, The Netherlands

▶ Issuing Authority / *Autorité de délivrance*

National Measurement Office (NMO),
United Kingdom

R049/2006-GB1-2011.03 Rev. 1 (MAA)
Family of cold water meters utilising a common volume measuring element, with a nominal capacity of 3.25 revs/litre and having a Q^3 of 10 m^3/h or 16 m^3/h

Elster Metering Ltd., 130 Camford Way, Sundon Park,
GB-LU3 3AN Luton, Bedfordshire, United Kingdom

▶ Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB),
Germany

R049/2006-DE1-2012.05
Water meter intended for the metering of cold potable water and hot water. Single jet meter with mechanical register - Type: Minomess A, Minomess B

Zenner International GmbH & Co. KG, Römerstadt 4,
DE-66121 Saarbrücken, Germany

R049/2006-DE1-2012.06
Water meter intended for the metering of cold potable water and hot water. Multi jet meter with mechanical indicating device - Type: MTK-S1

Zenner International GmbH & Co. KG, Römerstadt 4,
DE-66121 Saarbrücken, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic catchweighing instruments
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique

R 51 (1996)

Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R051/1996-DE1-1999.03 Rev. 2
Checkweigher for static weighing - Type CS...CS
Optima consumer GmbH, Geschwister-Scholl-St. 89, DE-74523 Schwabish Hall, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic catchweighing instruments
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique

R 51 (2006)

Issuing Authority / *Autorité de délivrance*

NMi Certin B.V., The Netherlands

R051/2006-NL1-2012.01
Automatic catchweighing instrument - Type: DACS-G-S015... and DACS-G-S060
Ishida Europe Ltd., 11 Kettles Wood Drive, Woodgate Business Park, Birmingham B32 3DB, United Kingdom

R051/2006-NL1-2012.02
Automatic catchweighing instrument - Type: LI-4600
Teraoka Seiko Co. Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, JP-146-8580 Tokyo, Japan

R051/2006-NL1-2012.03
Automatic catchweighing instrument - Type: DPS-4600..
Teraoka Seiko Co. Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, JP-146-8580 Tokyo, Japan

R051/2006-NL1-2012.04
Automatic catchweighing instrument - Type: AW-4600CPR-..., or AW-4600...
Teraoka Seiko Co. Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, JP-146-8580 Tokyo, Japan

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Metrological regulation for load cells (applicable to analog and/or digital load cells)
Réglementation métrologique des cellules de pesée (applicable aux cellules de pesée à affichage analogique et/ou numérique)

R 60 (2000)

Issuing Authority / *Autorité de délivrance*

Dansk Elektronik, Lys & Akustik (DELTA), Denmark

R060/2000-DK3-2011.01 Rev. 1
Stainless steel, compression load cell with digital output - Type: TZD
Societa Cooperativa Bilanciai Campogalliano a.r.l, Via S. Ferrari, 16, IT-41011 Campogalliano (Modena), Italy

Issuing Authority / *Autorité de délivrance*

NMi Certin B.V., The Netherlands

R060/2000-NL1-2012.01 (MAA)
Digital load cell - Type: PW15 AHI
Hottinger Baldwin Messtechnik GmbH, Im Tiefen See 45, DE-64293 Darmstadt, Germany

R060/2000-NL1-2012.04 (MAA)
Single point load cell
Keli Electric Manufacturing (Ningbo) Co. Ltd., N° 199 Changxing Road, Jiangbei District, CN-315033 Ningbo, P.R. China

R060/2000-NL1-2012.51 (MAA)
Bending beam load cell, with strain gauges - Type: PA06, PA06MG
Beijing True-Tec Co. Ltd., 4/F, Bldg. 2, N°. 8, Hong Da Bei Lu, BDA, CN-100176 Beijing, P.R. China

R060/2000-NL1-2012.52 (MAA)
Single point load cell - Type: L6D-xx-xxx-xxx-xx Series
Zhonghang Electronic Measuring Instruments Co. Ltd. (ZEMIC), Xinyuan Road,The North Zone of EDZ, Hanzhong, P.O. Box 2, CN- 723000 Hanzhong- ShaanXi, P.R. China

R060/2000-NL1-2012.53 (MAA)
Compression load cell, with strain gauges, equipped with electronics - Type: GDD or SLC720
Mettler-Toledo (Changzhou) Precision Instruments Ltd., 5, Middle HuaShan Road, Xinbei District, CN-213022 ChangZhou, Jiangsu, P.R. China

R060/2000-NL1-2012.55 (MAA)
Bending beam load cell, with strain gauges - Type: SLP845
Mettler-Toledo (Changzhou) Precision Instruments Ltd., 5, Middle HuaShan Road, Xinbei District, CN-213022 ChangZhou, Jiangsu, P.R. China

R060/2000-NL1-2012.55 Rev. 1 (MAA)
Bending beam load cell, with strain gauges - Type: SLP845
Mettler-Toledo (Changzhou) Precision Instruments Ltd., 5, Middle HuaShan Road, Xinbei District, CN-213022 ChangZhou, Jiangsu, P.R. China

R060/2000-NL1-2013.01 (MAA)
Compression load cell, with strain gauges - Type: CP-1
Zhejiang South-Ocean Sensor Manufacturing Co. Ltd., N° 58, Nanyang Road, Qianyuan Town, Deqing County, CN-313216 Huzhou City, Zhejiang Province, P.R. China

R060/2000-NL1-2013.02 (MAA)
Compression load cell with strain gauges - Type: CP-11
Zhejiang South-Ocean Sensor Manufacturing Co. Ltd., N° 58, Nanyang Road, Qianyuan Town, Deqing County, CN-313216 Huzhou City, Zhejiang Province, P.R. China

R060/2000-NL1-2013.03 (MAA)
Compression load cell, with strain gauges - Type: CP-15
Zhejiang South-Ocean Sensor Manufacturing Co. Ltd., N° 58, Nanyang Road, Qianyuan Town, Deqing County, CN-313216 Huzhou City, Zhejiang Province, P.R. China

R060/2000-NL1-2013.04 (MAA)
Compression load cell, with strain gauges - Type: GX1SH
Zhejiang South-Ocean Sensor Manufacturing Co. Ltd., N° 58, Nanyang Road, Qianyuan Town, Deqing County, CN-313216 Huzhou City, Zhejiang Province, P.R. China

▶ **Issuing Authority / *Autorité de délivrance***

National Measurement Office (NMO), United Kingdom

R060/2000-GB1-2009.10 Rev. 2 (MAA)
Strain Gauge Compression Load Cell - Type T302x
Avery Weigh-Tronix, Foundry Lane, Smethwick, West Midlands B66 2LP, United Kingdom

R060/2000-GB1-2011.05 Rev. 1
T301x Digital compression alloy steel load cell
Avery Weigh-Tronix, Foundry Lane, Smethwick, West Midlands B66 2LP, United Kingdom

R060/2000-GB1-2012.08 (MAA)
BSA-XXXXL Steel compression (beam) strain gauge load cell (where XXXX relates to the load cell capacity).
CAS Corporation, #19, Ganap-Ri, Gwangjuk-Myoun, Yangju-Si, KR-482-841 Kyunggi-Do, Korea (R.)

▶ **Issuing Authority / *Autorité de délivrance***

Physikalisch-Technische Bundesanstalt (PTB), Germany

R060/2000-DE1-2010.05 Rev. 1 (MAA)
Strain gauge single point load cell - Type: PW25
Hottinger Baldwin Messtechnik GmbH, Im Tiefen See 45, DE-64293 Darmstadt, Germany

R060/2000-DE1-2012.01 Rev. 1
Digital strain gauge compression load cell - Type: PR 6204
Sartorius Mechatronics T&H GmbH, Meiendorfer Strasse 205, DE-22145 Hambourg, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Nonautomatic weighing instruments
Instruments de pesage à fonctionnement non automatique

R 76-1 (1992), R 76-2 (1993)

▶ **Issuing Authority / *Autorité de délivrance***

NMi Certin B.V., The Netherlands

R076/1992-NL1-2012.33
Non-automatic weighing instrument - Type> DPS-5600
Teraoka Seiko Co. Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, JP-146-8580 Tokyo, Japan

R076/1992-NL1-2012.49
Non automatic weighing instrument - Type: AW-5600..EX
Teraoka Seiko Co. Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, JP-146-8580 Tokyo, Japan

R076/1992-NL1-2013.01
Non automatic weighing instrument - Type: SWS-5600
Teraoka Seiko Co. Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, JP-146-8580 Tokyo, Japan

▶ **Issuing Authority / *Autorité de délivrance***

Physikalisch-Technische Bundesanstalt (PTB), Germany

R076/1992-DE1-2005.10 Rev. 2
Non-automatic electromechanical weighing instrument for persons - Types: M704x2, M764x2, COS01A, COS01B, COS01C
Seca GmbH & Co. kg., Hammer Steindamm 9-25, DE-22089 Hamburg, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Non-automatic weighing instruments
Instruments de pesage à fonctionnement non automatique

R 76-1 (2006), R 76-2 (2007)

▶ Issuing Authority / *Autorité de délivrance*

Dansk Elektronik, Lys & Akustik (DELTA), Denmark

R076/2006-DK3-2012.04
Non automatic weighing instrument - Type: GEC / GEW / KSP / KSLP / MEP / MELP

Kingship Weighing Machine Corp., 739, Renhua Road, Dali City, TW-Taichung 412, Taiwan R.O.C, Chinese Taipei

▶ Issuing Authority / *Autorité de délivrance*

Office Fédéral de Métrologie METAS, Switzerland

R076/2006-CH1-2009.01 Rev. 2 (MAA)
Non-automatic weighing instrument - Type: Newclassic MF

Mettler-Toledo AG, Im Langacher, CH-8606 Greifensee, Switzerland

▶ Issuing Authority / *Autorité de délivrance*
State General Administration for Quality Supervision and Inspection and Quarantine (AQSIQ), China

R076/2006-CN1-2013.01 (MAA)
Non-automatic weighing instrument - Type: ACS-15, ACS-30

Zhongshan Camry Electronics Co. Ltd., Banshawan Industrial Park, Qiwan Road East, East District, Zhongshan, Guangdong 528-403, P.R. China

R076/2006-CN1-2013.02 (MAA)
Weighing indicator - TypeXK3119, XK3119-WMK(B)

Guangdong Huapu Electrial Applicance Group Co. Ltd., Lunjiao Section, #105 National Highway, Shunde, Guangdong 528308, P.R. China

▶ Issuing Authority / *Autorité de délivrance*

Laboratoire National de Métrologie et d'Essais, Certification Instruments de Mesure, France

R076/2006-FR2-2013.01 Rev. 0 (MAA)
Indicator - Type: DI-517 / DI-517 SS

Shanghai Teraoka Electronic Co. Ltd., Tinglin Industry Developmental Zone, Jinshan District, CN-201505 Shanghai, P.R. China

▶ Issuing Authority / *Autorité de délivrance*

NMi Certin B.V., The Netherlands

R076/2006-NL1-2010.13 Rev. 1 (MAA)
Non automatic weighing instrument - Type: 830x/840x (where x represents a number from 0 to 9)

Datalogic Scanning, Inc., 959 Terry Street, Oregon 97402-9150, Eugene, USA

R076/2006-NL1-2012.29 (MAA)
Non-automatic weighing instrument - Type: FMM-Fx, PD350x, PD150x, FMM-PDx, PD300x

Fook Tin Technologies Ltd., 4/F Eastern Center, 1065 King's Road, Quarry Bay, Hong Kong

R076/2006-NL1-2012.37 (MAA)
Indicator - Type: D2008

Keli Electric Manufacturing (Ningbo) Co. Ltd., N° 199 Changxing Road, Jiangbei District, CN-315033 Ningbo, P.R. China

R076/2006-NL1-2012.38 (MAA)
Indicator - Type: XK3118K5

Keli Electric Manufacturing (Ningbo) Co. Ltd., N° 199 Changxing Road, Jiangbei District, CN-315033 Ningbo, P.R. China

R076/2006-NL1-2012.39
Non-automatic weighing instrument - Type: DS-425

Shanghai Teraoka Electronic Co. Ltd., Tinglin Industry Developmental Zone, Jinshan District, CN-201505 Shanghai, P.R. China

R076/2006-NL1-2012.41
Non-automatic weighing instrument - Type: RM-5800II

Shanghai Teraoka Electronic Co. Ltd., Tinglin Industry Developmental Zone, Jinshan District, CN-201505 Shanghai, P.R. China

R076/2006-NL1-2012.44 (MAA)
Indicator - Type: RT20i

Vishay Israel Ltd. Transducers, 2 Haofan St., 58814 Holon, Israel

R076/2006-NL1-2012.46 (MAA)
Non-automatic weighing instrument - Type: Ranger 3000 R31P..., Ranger Count 3000 RC31P..., Valor 7000 V71P...
Ohaus Corporation, 7, Campus Drive, Suite 310, NJ 07054, Parsippany, USA

R076/2006-NL1-2012.47 (MAA)
Indicator - Type: RT20i
Vishay Israel Ltd. Transducers, 2 Haofan St., 58814 Holon, Israel

R076/2006-NL1-2012.48 (MAA)
Indicator - Type 480-2A
Rice Lake Weighing Systems, 230 West Coleman Street, 54868 Rice Lake, Wisconsin, USA

▶ **Issuing Authority / *Autorité de délivrance***

National Measurement Office (NMO), United Kingdom

R076/2006-GB1-2011.02 Rev. 1
Type: 3590E, CPWE, DFW, and DGT Series
Dini Argeo Srl, Via Della Fisica, 20, IT-41042 Spezzano di Fiorano (MO), Italy

R076/2006-GB1-2012.03 Rev. 1
Type: IPE100, IPE90, IPC, and IPE50 Series
Scaime S.A.S, Technosite ALTEA, BP 501, FR-74105 Annemasse Cedex, France

R076/2006-GB1-2012.14 (MAA)
Type: DD1010, DD1010IC, DD1010I, DD1010H, DD1010ICH, DD1010IH
Societa Cooperativa Bilanciai Campogalliano a.r.l, Via S. Ferrari, 16, IT-41011 Campogalliano (Modena), Italy

▶ **Issuing Authority / *Autorité de délivrance***

Physikalisch-Technische Bundesanstalt (PTB), Germany

R076/2006-DE1-2012.03
Non automatic electromechanical weighing instrument - Type SQP-A, SQP-B, SQP-C, SQP-D, SQP-E
SARTORIUS Weighing Technology GmbH, Weender Landstrasse 94-108, DE-37075 Gottingen, Germany

R076/2006-DE1-2012.04
Non automatic electromechanical weighing instrument - Type: Wcon-I
OAS AG, Linzer Str. 7, DE-28359 Bremen, Germany

R076/2006-DE1-2013.01
Indicating and operating terminal - Type: VOP280xx
Schenk Process GmbH, Pallaswiesenstrasse 100, DE-64293 Darmstadt, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic level gauges for fixed storage tanks
Jaugeurs automatiques pour les réservoirs de stockage fixes

R 85 (2008)

▶ **Issuing Authority / *Autorité de délivrance***

NMi Certin B.V., The Netherlands

R085/2008-NL1-2012.03
Automatic level gauge for measuring the level of liquid in storage tanks, models Smartradar Flexline XP and Smartradar Flexline HP, with antennas F08, W06, H04, S06, S08, S10 and S12
Enraf B.V., Delftechpark 39, NL-2628 XJ Delft, The Netherlands

R085/2008-NL1-2012.04
Automatic level gauge for measuring the level of liquid in storage tanks, models Smartradar Flexline XP and Smartradar Flexline HP, with antennas F08, W06, H04, S06, S08, S10 and S12
Enraf B.V., Delftechpark 39, NL-2628 XJ Delft, The Netherlands

OIML CERTIFICATE SYSTEM

List of OIML Issuing Authorities

The list of OIML Issuing Authorities is published in each issue of the OIML Bulletin. For more details, please refer to our web site: www.oiml.org/certificates. Changes since the last issue of the Bulletin are marked in red.

		R 16	R 21	R 31	R 35	R 49	R 50	R 51	R 58	R 60	R 61	R 75	R 76	R 81	R 85	R 88	R 93	R 97	R 98	R 99	R 102	R 104	R 105	R 106	R 107	R 110	R 112	R 113	R 114	R 115	R 117/118	R 122	R 126	R 128	R 129	R 133	R 134	R 136
AT1	Bundesamt für Eich- und Vermessungswesen (BEV)						■	■	■		■		■		■	■		■	■		■	■		■	■	■			■	■	■							
AU1	National Measurement Institute (NMI)					■	■	■		■			■		■									■	■						■		■		■			
BE1	SPF Economie, PME, Classes Moyennes et Energie												■					■	■																			
BG1	State Agency for Metrology and Technical Surveillance (SAMTS)												■						■																			
BR1	Instituto Nacional de Metrologia, Normalização e Qualidade Industrial (INMETRO)												■																									
CH1	Institut fédéral de métrologie (METAS)	■		■		■	■	■		■	■		■					■	■				■	■	■						■						■	
CN1	General Administration of Quality Supervision, Inspection and Quarantine of P. R. China (AQSIQ)			■			■	■		■	■		■					■	■						■						■						■	
CZ1	Czech Metrology Institute (CMI)					■							■	■	■								■								■						■	
DE1	Physikalisch-Technische Bundesanstalt (PTB)	■		■	■	■	■	■	■	■	■		■		■	■		■	■	■	■	■	■	■	■	■			■	■	■		■	■	■	■		■
DK1	The Danish Accreditation and Metrology Fund (DANAK)						■	■		■	■		■						■				■	■	■						■				■		■	
DK2	FORCE Certification A/S					■																																
DK3	Dansk Elektronik, Lys & Akustik (DELTA)						■	■		■	■		■											■	■										■		■	
ES1	Centro Español de Metrología (CEM)					■		■		■	■		■					■	■														■					
FI1	Inspecta Oy						■	■		■	■		■		■									■	■						■							
FR1	Ministère de l'Economie, de l'Industrie et de l'Emploi (MEIE)	*All activities and responsibilities were transferred to FR2 in 2003*																																				
FR2	Laboratoire National de Métrologie et d'Essais (LNE)		■	■		■	■	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■			■	■	■		■		■		■	
GB1	National Measurement Office (NMO) - Formerly NWML		■		■	■	■	■		■	■	■	■		■				■				■	■	■						■				■		■	
GB2	National Physical Laboratory (NPL)																	■																				
HU1	Hungarian Trade Licensing Office (MKEH)												■																									
JP1	National Metrology Institute of Japan / National Institute of Advanced Industrial Science and Technology (NMIJ / AIST)									■			■																	■	■							
KR1	Metrology and Measurement Division (KATS)												■																									
NL1	NMi Certin B.V.		■	■		■	■	■		■	■		■	■	■			■		■			■	■	■						■		■	■	■		■	
NL2	KIWA Nederland B.V.					■																																
NO1	Norwegian Metrology Service (Justervesenet)						■	■			■		■										■	■	■						■				■			
NZ1	Measurement and Product Safety Service (MAPSS Wellington)												■																									
PL1	Central Office of Measures (GUM)												■						■		■																	
RO1	Bureau Roumain de Métrologie Légale (B.R.M.L.)																	■	■							■			■	■								
RU1	Russian Research Institute for Metrological Service (VNIIMS)			■		■	■	■	■	■	■		■		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
SE1	Swedish National Testing and Research Institute AB (S.P.)						■	■		■	■		■		■				■					■	■						■							
SI1	Metrology Institute of the Republic of Slovenia (MIRS)												■																									
SK1	Slovak Legal Metrology					■							■																		■							
US1	NCWM, Inc.									■			■																									
VN1	Directorate for Standards and Quality (STAMEQ)												■																									

The OIML is pleased to welcome the following new

Member State

Colombia
Mr. Alejandro Giraldo LOPEZ

Corresponding Members

Uganda

Yemen

OIML Meetings

23–25 July 2013

TC 17/SC 1/p1 Revision of R 59
(Moisture meters for cereal grains and oilseeds)

and

TC 17/SC 8/p1 New Recommendation
(Protein measuring instruments for cereal grains and oilseeds)

NIST, Gaithersburg, USA

23–27 September 2013

TC 6 (Prepackaged products)
METAS, Bern, Switzerland

7–11 October 2013

48th CIML Meeting and Associated Events
Ho Chi Minh City, Viet Nam

Committee Drafts

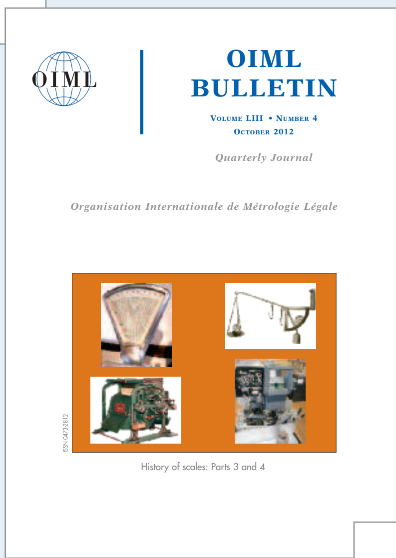
Received by the BIML, 2012.12 – 2013.03

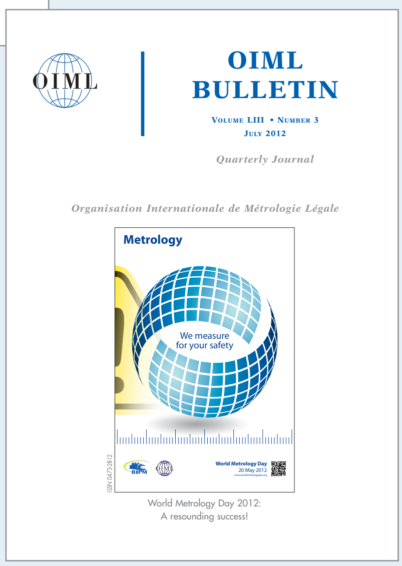
Revision of OIML R 139-1: Compressed gaseous fuel measuring systems for vehicles. Part 1: Metrological and technical requirements	E	2 CD	TC 8/SC 7	NL
Revision of OIML R 139-2: Compressed gaseous fuel measuring systems for vehicles. Part 2: Metrological controls and performance tests	E	2 CD	TC 8/SC 7	NL
OIML R 137-3: Gas meters. Part 3: Report format for type evaluation	E	1 CD	TC 8/SC 7	NL

Call for papers

OIML Members
RLMOs
Liaison Institutions
Manufacturers' Associations
Consumers' & Users' Groups, etc.

- Technical articles on legal metrology related subjects
- Features on metrology in your country
- Accounts of Seminars, Meetings, Conferences
- Announcements of forthcoming events, etc.





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- a titled, typed manuscript in Word or WordPerfect either on disk or (preferably) by e-mail;
- the paper originals of any relevant photos, illustrations, diagrams, etc.;
- a photograph of the author(s) suitable for publication together with full contact details: name, position, institution, address, telephone, fax and e-mail.

Note: Electronic images should be minimum 150 dpi, preferably 300 dpi.

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